

New Scientist

WEEKLY 16 September 2023

HOW TO FIGHT FAKE NEWS IN THE AGE OF AI

COULD SMART TOILETS LEAK YOUR HEALTH DATA?

ASTEROID HIT BY NASA IS BEHAVING WEIRDLY

CBD

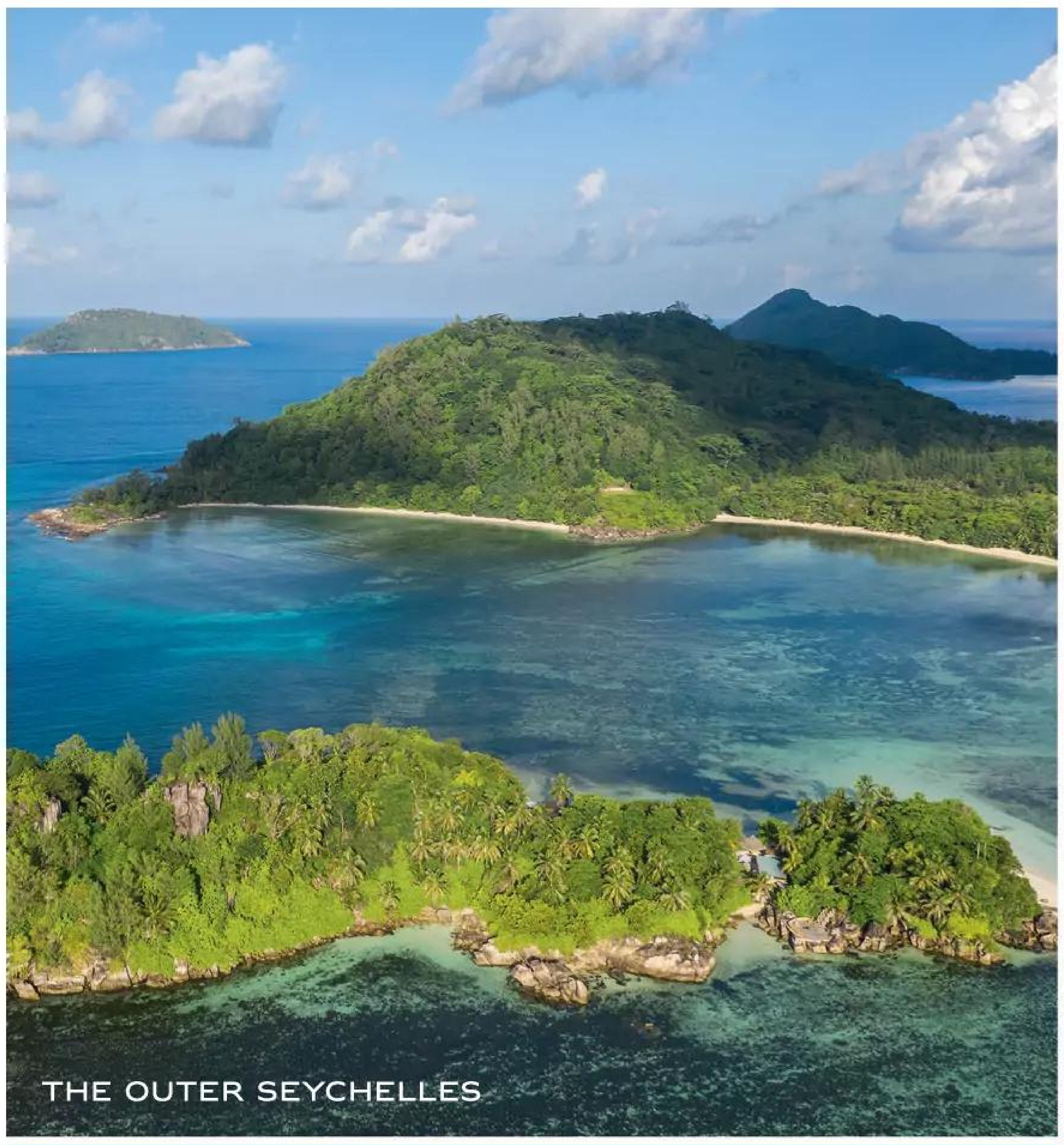
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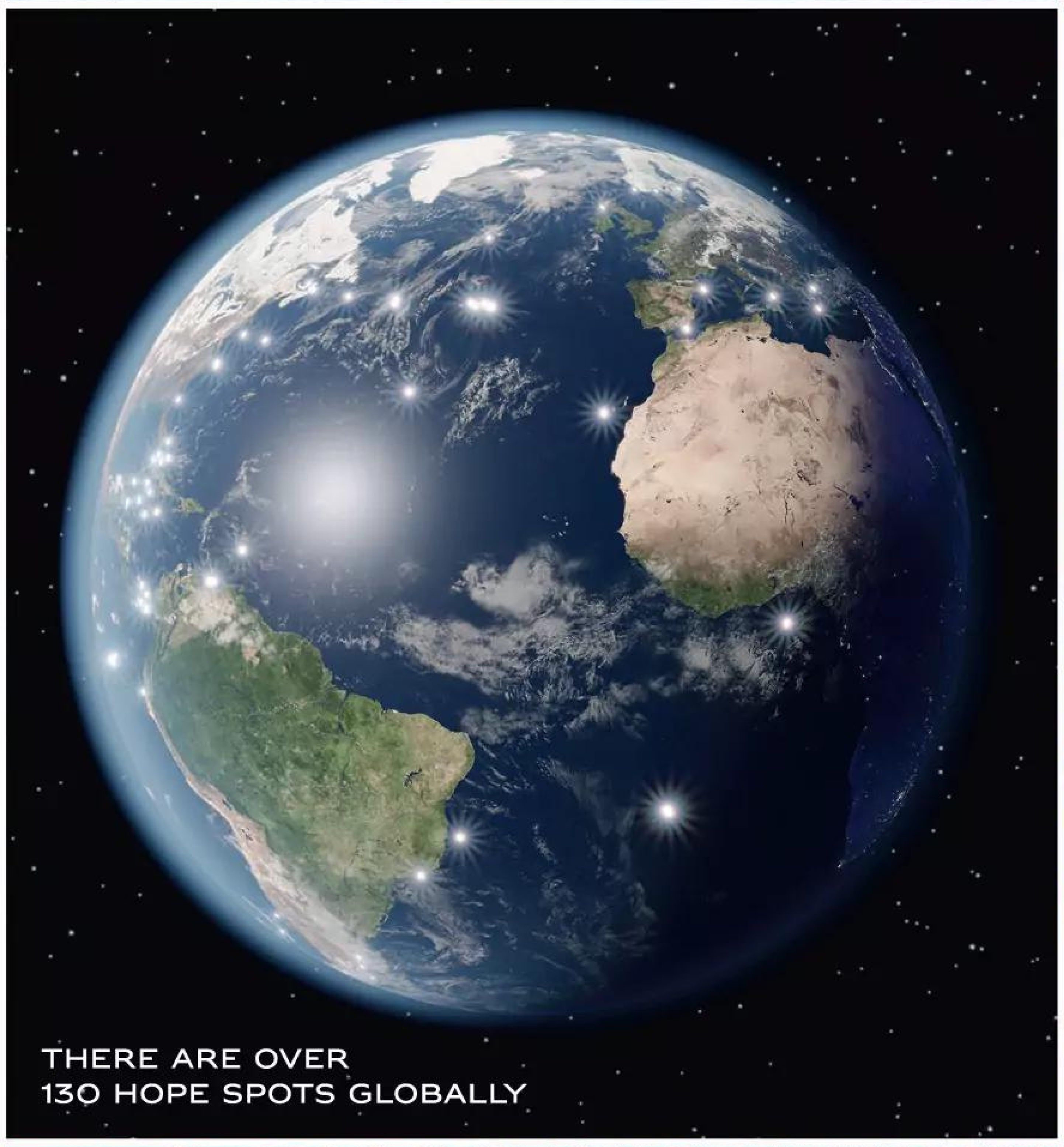
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THE OUTER SEYCHELLES


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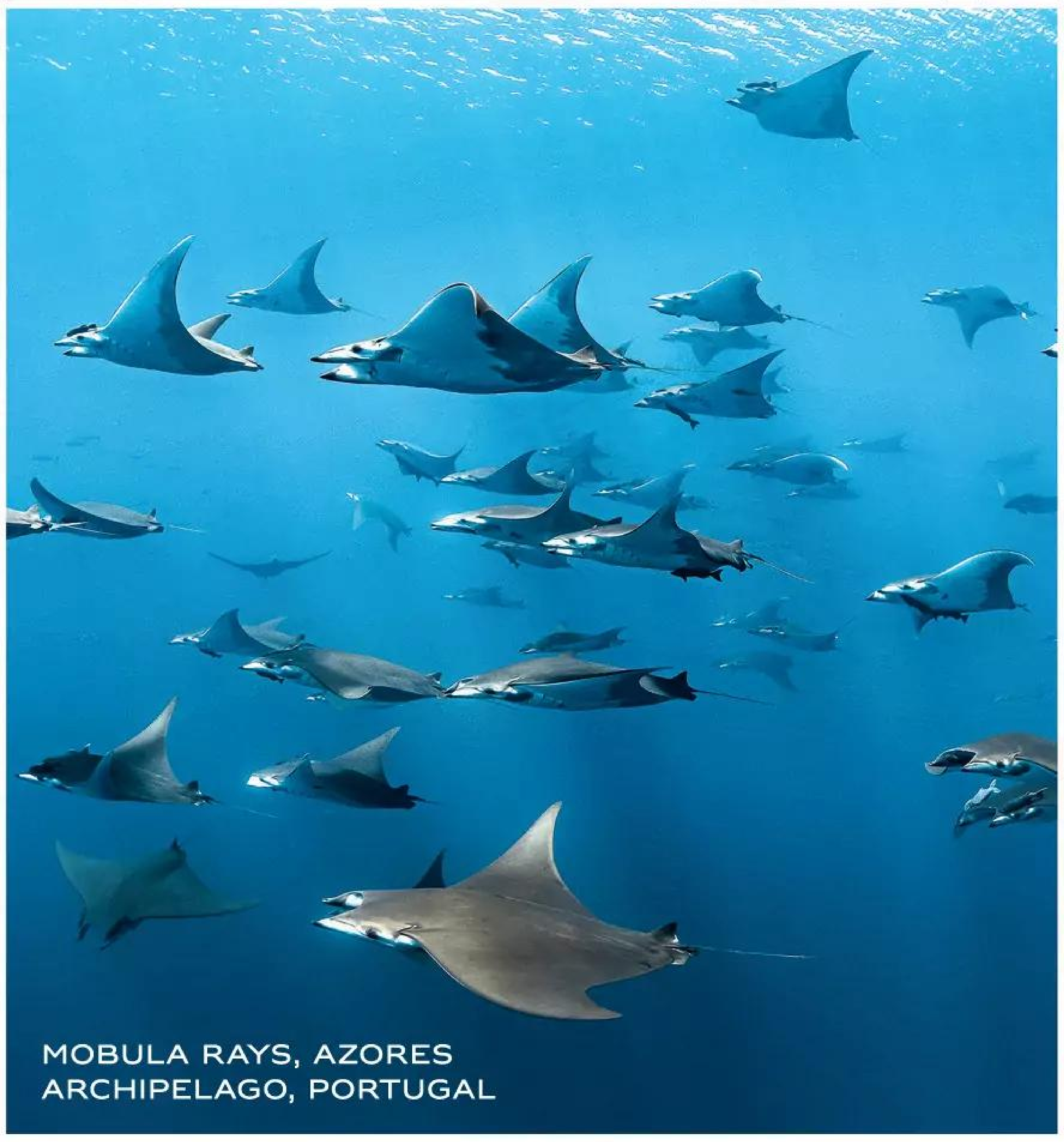

FLORIDA GULF COASTLINE, UNITED STATES


SYLVIA EARLE EXPLORES COCOS ISLAND, COSTA RICA


THERE ARE OVER 130 HOPE SPOTS GLOBALLY


SYLVIA EARLE WITH VOLUNTEERS, THE OUTER SEYCHELLES


GREAT BARRIER REEF, AUSTRALIA


MOBULA RAYS, AZORES ARCHIPELAGO, PORTUGAL


SEA LION, GALÁPAGOS, ECUADOR





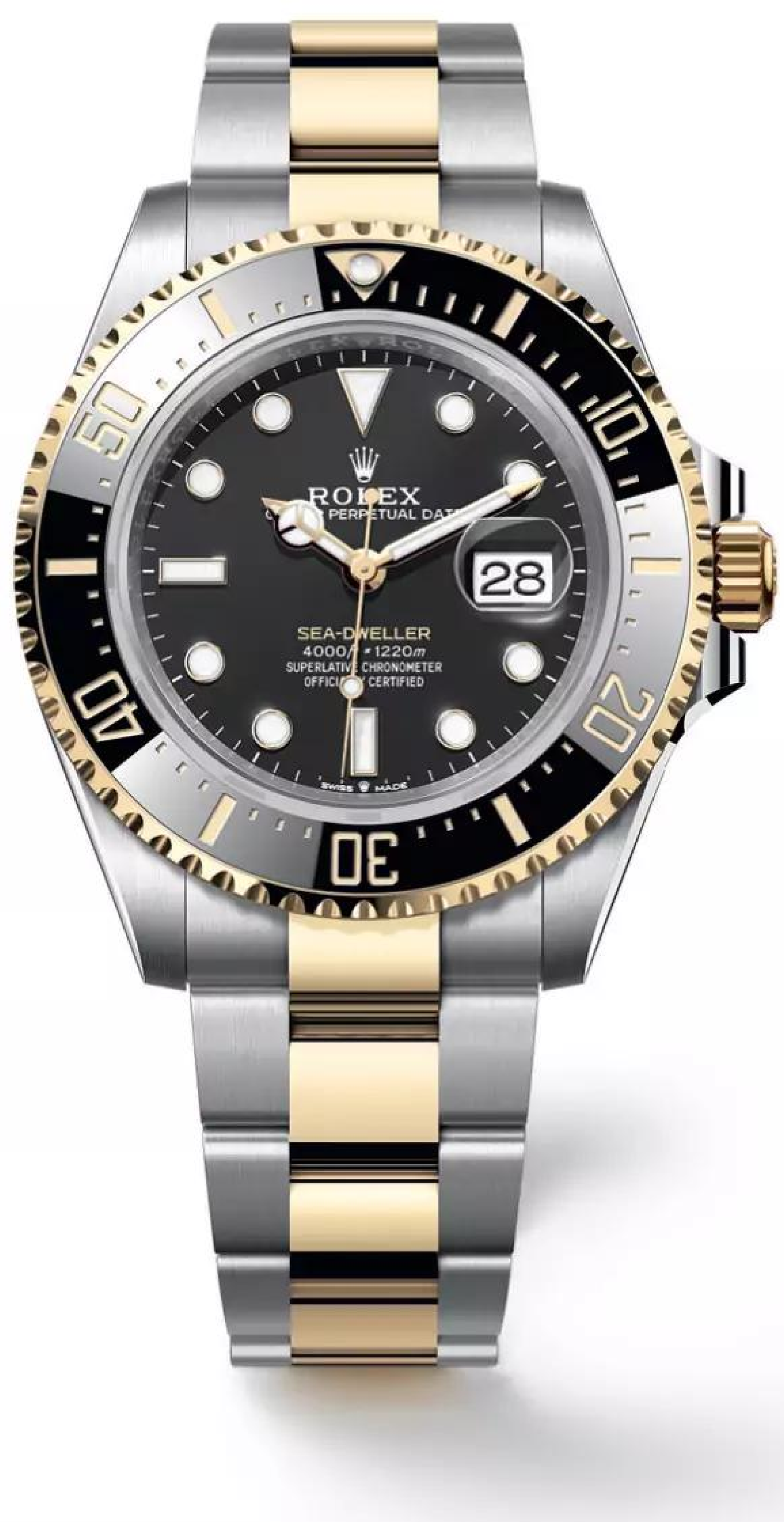
MISSION BLUE

ON OUR WATCH

Hope can now be spotted across all our planet's seas and oceans. Sites are made into aquatic havens by local communities, to safeguard the richness and diversity of the ecosystems they depend on. Sylvia Earle's invaluable experience as an explorer and marine biologist continues to help further their goal, through her organisation, Mission Blue. Together, they have created over 130 Hope Spots and counting. Carrying a message of hope for generations to come. It is that vision, that dedication to a perpetual planet, which we are proud to stand by. **For as long as it is needed.**

Rolex supports Mission Blue in its commitment to protecting 30% of the oceans by 2030.

#Perpetual



OYSTER PERPETUAL
SEA-DWELLER

ROLEX Perpetual Planet Initiative

ROLEX

This week's issue

On the cover

32 CBD
Wonder drug or waste of money?



Vol 259 No 3456
Cover image: Murugiah

36 How to fight fake news in the age of AI

14 Could smart toilets leak your health data?

9 Asteroid hit by NASA is behaving weirdly

12 Electric mist **12** Rewilding rhinos **46** Do dogs know that dogs are dogs?

New Scientist Live

There are just three weeks to go until our flagship science show. Visit our website to explore the latest programme of talks, speakers and experiences

newscientist.com/nslmag

News

8 Mass heat deaths
Rising temperatures may make it hard to survive outside

10 Three-body problem
Record 12,000 solutions found for fiendish puzzle

18 Brain cell discovery
New hybrid type of nerve cell is found in the brain

Views

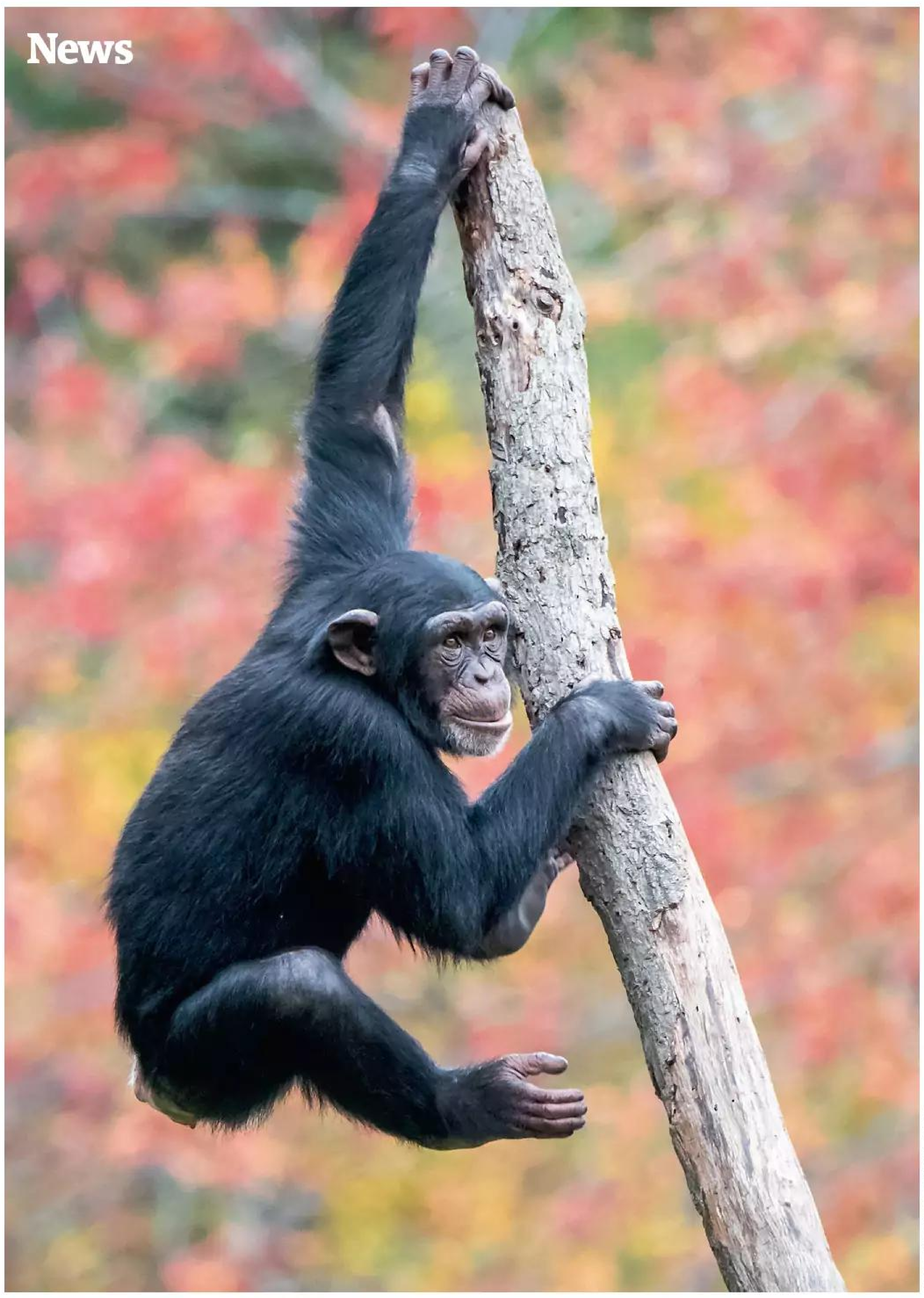
21 Comment
Developing the 'sharenting' habit prenatally has big impacts, says Elaine Kasket

22 The columnist
Chanda Prescod-Weinstein on physics and *Emmerdale*

24 Aperture
Fabulous fungi from the Andes

26 Letters
Maybe it is time for people to ditch their smartphones

28 Culture
Explore artificial intelligence in four worrying books



ABESELOM ZERIT/ALAMY

17 Downwardly mobile Primate arm joint evolution linked to climbing

Features

32 CBD: Hope or hype?
From insomnia to Alzheimer's – the evidence behind CBD's claimed benefits

36 Information wars
AI is supercharging fake news, but governments and researchers are fighting back

41 Prairie power
How renewable energy can restore North America's prairies

The back pages

44 Stargazing at home
How to spot Cygnus

45 Puzzles
Try our crossword, quick quiz and logic puzzle

46 *Almost* the last word
How do dogs recognise that other dogs are dogs?

48 Feedback
Dead ringers, head games and trivial superpowers

48 Twisteddoodles for *New Scientist*
Picturing the lighter side of life

Elsewhere on New Scientist

NS Live

Busting myths about being female

Listen to zoologist Lucy Cooke reveal what it means to be female with wild tales from the animal queendom. On 7 October at New Scientist Live, Cooke will dispel stereotypes that female animals are just carers and baby-makers. Female elephants and orcas, for instance, are the empathetic leaders of some of the smartest animal societies. Some species have dispensed with males altogether, taking over as a self-cloning sisterhood.

newscientist.com/nslmag

Tour

Science of Antarctica: The Weddell Sea

Journey to the site where Ernest Shackleton's ship capsized. Encounter icebergs as tall as skyscrapers and watch humpback whales and leopard seals. Your guide is broadcaster Saunders Carmichael-Brown, who was aboard the expedition that discovered the remains of Shackleton's ship last year. The 15-day tour starts on 23 March 2024 and costs £11,399.

newscientist.com/tours

Podcast

Weekly

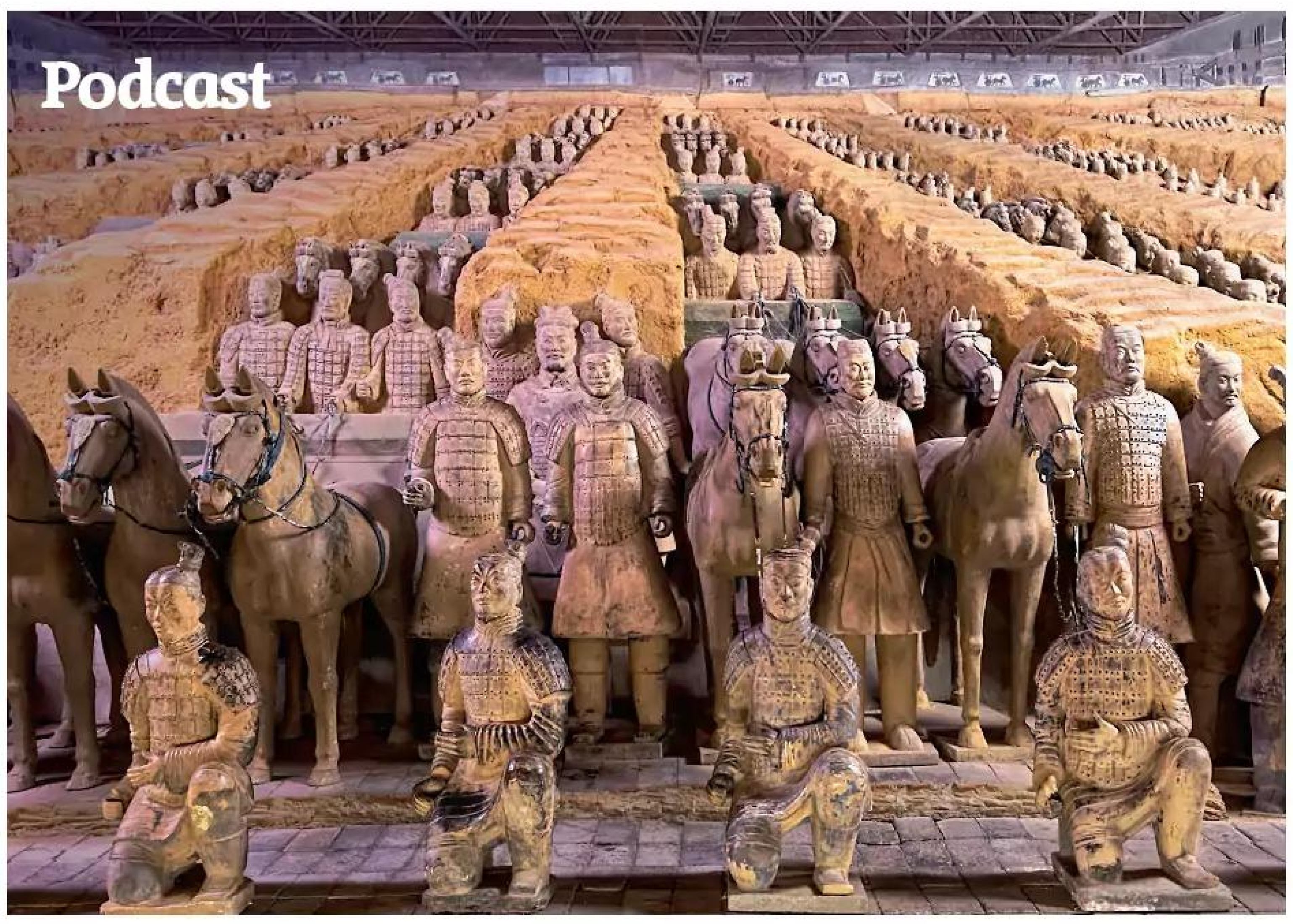
The team discusses the first bridge being built over a moving glacier – and how climate change forces innovative engineering. Hear how archaeologists have reconstructed the shoes of China's Terracotta Army. Plus, can quantum batteries solve our energy storage problems?

newscientist.com/nspod



TARPAN/SHUTTERSTOCK

Weddell Sea Humpback whales near Shackleton's shipwreck site



DAVID DAVIS PHOTOPRODUCTIONS RF/ALAMY

Terracotta Army Ancient soldiers had slip-resistant shoes

Video

How to unlock a river

Centuries of industrialisation have reshaped almost all of the UK's waterways with artificial structures like weirs, which hinder their flow and prevent fish migrating upstream. Now, a project on the UK's longest river called Unlocking the Severn is building a series of fish passes to help endangered species reach their historic spawning grounds.

youtube.com/newscientist

Newsletter

Our Human Story

A wealth of hominin fossils from some of our closest ancestors have been found in Asia, but we still struggle to make sense of how they fit into the broader story of hominin migration. Michael Marshall untangles this web and finds close connections between these prehistoric populations.

newscientist.com/our-human-story

A note from the editor



Dear reader,

There are only three weeks to go until New Scientist Live, our annual extravaganza in London. If you are around that weekend, do please join us. You can also access the events online this year if you are keen to take part but aren't able to attend in person.

If you haven't been before, the show is a mixture of live talks by some of the world's most interesting scientists, technologists and environmentalists, and also a bustling exhibition floor with a hugely diverse range of stalls and activities. Last year, my favourite exhibit was a Boston Dynamics robot dog (which is returning this year, by the way), but my must-do this October is definitely the flint-knapping activity – since, even though I am a keen collector of stone tools, I have never actually tried to make one before!

The talks are always the real highlight for me though. I am probably most looking forward to astrophysicist Richard Ellis on the Saturday, who will update us on the James Webb Space Telescope and everything we have learned from it so far. In fact, early bird discounted tickets for the Saturday are still available, but be quick as the offer ends on 17 September.

All the details of this year's show, and tickets, can be found at newscientist.com/nslmag.

All the very best to you, and I hope to see you soon.

Emily Wilson
New Scientist editor-in-chief



As our farmers know all too well: no pain, no grain.

They say nothing worth having comes easy. Unfortunately for our farmers that's true of the barley we use to brew our beers. We use a classic variety called Golden Promise, grown to our own unique specification. The biscuity, golden malt it produces is the perfect partner to our natural spring water, and is vital to Landlord's depth and delicate balance of flavour. It's also a type of barley that's notoriously hard to grow, and our exacting specification makes it even more difficult. Which makes it a costly ingredient and a real challenge even for experienced farmers. Luckily we can offer some liquid therapy.

Timothy Taylor's 1858 Championship Beers Landlord The Classic Pale Ale ABV 4.3%

All for that taste of Taylor's

Divided over cannabis

Medical use of cannabis products is on the rise – it is finally time for proper research

ATTITUDES about cannabis have shifted dramatically in recent years across much of the world. The number of people who view it as a dangerous drug has steadily declined in the past two decades, while the number who say they use it has shot up.

Much of this shift is down to increased interest in the potential medical benefits. According to the latest United Nations drug report on herbal cannabis for medical use, 64 countries now have such provisions.

In the US, this change in opinions has been particularly pronounced, and cannabis is now legal for medical or recreational use in 38 states. Yet despite the increasing popularity of the drug and the compounds in it, most cannabis research is still at a very early stage and claims about it can outstrip the evidence.

To help make sense of it all, our new reporting series will look at how cannabis took over the world and examine some of the urgent questions we face – everything from its true medical promise to the environmental impact of its rise in use.

In this week's cover story (see page 32), we home in on one of the trendiest uses of cannabis products for health and well-being: CBD, or cannabidiol. A compound found in cannabis, CBD is said to help with all manner of ills, but without the high associated with the drug. We ask whether the promises live up to the hype.

"Many advocates portray cannabis as harmless. Detractors say its harms outweigh any benefits"

Unfortunately, doing high-quality research on cannabis in all its guises, and obtaining reliable evidence on its health effects, is fraught with challenges, not least the fact it is a polarising issue. Because cannabis is natural in origin, many advocates portray it as harmless. Yet it has long been classed alongside heroin and LSD as a very dangerous drug, and detractors say its potential harms outweigh any benefits.

As more and more people turn to cannabis products for health reasons, it is time that we understand how it affects our bodies and minds. Our series aims to offer a clear-sighted guide to the current state of knowledge and the key open questions. You can explore all the articles at newscientist.com/cannabis. ■

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Helping keep future energy costs down
and cut UK carbon emissions to nothing
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News

Sole mates
Terracotta Army reveals secrets of ancient footwear **p9**

Antibody effect
Covid-19 linked to higher type 1 diabetes risk in children **p11**

Bite the good bite
Salamander eggs more likely to hatch if nibbled **p13**

Hybrid organs
Part-human kidneys grown in pigs for first time **p15**

Spooky action
Wireless charging may make quantum batteries better **p17**



Earth

Deadly earthquake strikes Morocco

People in the village of Tafeghaghte, Morocco, search for survivors in the rubble following a magnitude-6.8 earthquake that hit the High Atlas mountains on 8 September. The event destroyed many remote villages and more than 2800 people are known to have died, making it the country's deadliest earthquake in 60 years.

NATHAN LAINE/BLOOMBERG VIA GETTY IMAGES

New Scientist Live
Rethinking our approach to climate change
See Simon Sharpe offer ways to address the issue on 8 October
newscientist.com/nslmag

Environment

Risk of mass deaths in heatwaves

Global warming of 1.5°C to 2°C will lead to fierce conditions that even healthy people may not be able to survive when outside, finds **Michael Le Page**

AS THE world warms beyond 1.5°C, large parts of the world will start to have heatwaves so extreme that healthy young people could die within several hours if they fail to find respite, a study has warned.

This could result in mass deaths in places where people and buildings aren't adapted to extreme heat and air conditioning is rare, says Carter Powis at the University of Oxford.

"You could have a very extreme heatwave that departs from historical norms substantially, crosses this threshold and causes much more mortality than you would otherwise expect," he says. What we will see, particularly in Europe and North America, is an enormous increase in the incidence of these heatwaves as the world warms by between 1.5°C and 2°C, he says.

Global warming is already sparking more intense and more frequent heatwaves, so is causing large numbers of fatalities. It is estimated that there were 62,000 heat-related deaths across Europe in the summer of 2022, for instance. The vast majority of these were people aged over 65 who may have had existing health issues.

Survivability limit

Could global warming result in parts of the world getting so hot that healthy young people would die too?

Matthew Huber at Purdue University, Indiana, and his team set out to investigate this question in 2010. Based on theory, they decided that the limit of survivability is when the temperature measured by a thermometer covered in a wet cloth exceeds 35°C (95°F). This is the so-called wet-bulb temperature.



STEFANO MONTESI/CORBIS/GETTY IMAGES

Tourists seek shade under umbrellas as temperatures hit 45°C in Rome on 18 July

This measure reflects the fact that humidity affects our ability to stay cool by sweating. At this wet-bulb reading, we can no longer keep core body temperature in check naturally and it will rise to deadly levels if we don't take action to stay cool in other ways.

At present, the wet-bulb temperature very seldom exceeds 31°C (88°F) anywhere on Earth's surface. Huber's team concluded that large areas would only start to exceed the 35°C wet-bulb limit if the world warmed by more than 7°C – which is thought to be highly unlikely.

> "A wet-bulb reading of anything between 31°C and 35°C is very much in the danger zone"

However, recent studies suggest that parts of the tropics could exceed this limit at lower levels of warming. What's more, in practice most people couldn't survive anything close to a wet-bulb temperature of 35°C. "The original 35-degree limit was meant always as an upper limit," says Huber.

Last year, Daniel Vecellio at Pennsylvania State University and his colleagues tested 24 healthy young women and men to see how hot and humid it could get before their bodies were unable to stop their core temperature rising, the point at which heat is "noncompensable". Continued exposure to these conditions for several hours can result in death.

The findings suggest the survivability limit is closer to a 31°C wet-bulb reading, although other factors will affect this in reality. Because the volunteers weren't acclimatised to heat and were doing everyday tasks during the tests, this should be seen as a lower limit, with a 35°C wet-bulb temperature being the upper limit, says Powis.

"Anything between those two is very much in the danger zone," he says. "There's not just one threshold that is relevant to everyone. Different populations have different thresholds where there could suddenly be dramatic mortality outcomes."

Powis and his colleagues have now used data from weather stations and climate models to see where in the world such conditions may currently occur based on Vecellio's 31°C wet-bulb findings, and how this will change as the world warms.

Passing the threshold

All continents other than Antarctica will see a rise in such conditions. For example, with 1°C of warming – a level already passed – only 3 per cent of weather stations in Europe are likely to pass Vecellio's threshold more than once in 100 years. With warming of 2°C, 25 per cent are likely to. In the US, 20 per cent of stations are likely to pass the threshold more than once a century at 1°C of warming, rising to 28 per cent at 2°C (*Science Advances*, doi.org/gspx4q).

"Sometimes these human survivability limits are useful to understand the problem, but the reality is that we see a significant health burden on the population even at 'moderate' temperatures," says Dann Mitchell at the University of Bristol, UK. "Using a threshold-based temperature can be misleading, because even if it's hot outside, it doesn't mean that it's hot inside."

"I would like to highlight that all heat-related impacts on human health and well-being are preventable," says Raquel Nunes at the University of Warwick, UK. But with heatwaves becoming more frequent, more intense and more prolonged, urgent action is needed to avoid more heat-related deaths, she says. ■

Space

Asteroid hit by NASA spacecraft is behaving unexpectedly

Jonathan O'Callaghan

A HIGH school teacher and his students have discovered that an asteroid struck by a probe, in a test run for saving Earth should a collision one day threaten us, is behaving unexpectedly. The find could have implications for future planetary defence missions.

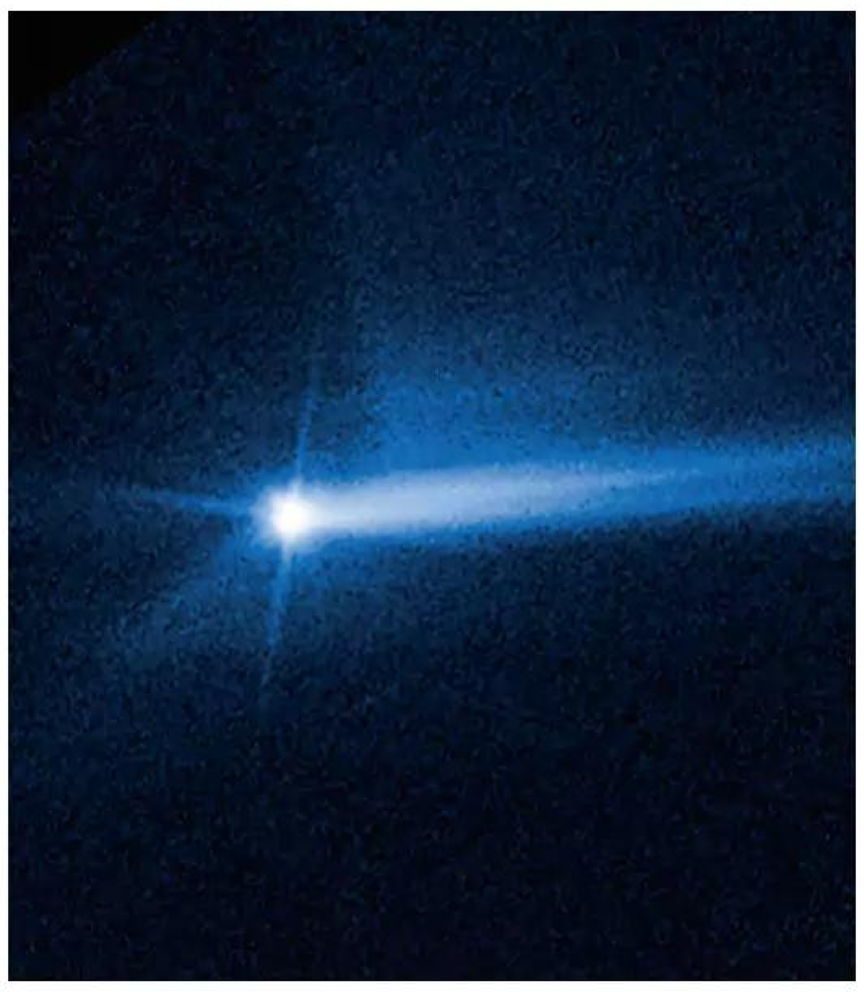
On 27 September 2022, NASA intentionally crashed its Double Asteroid Redirection Test (DART) vehicle into the asteroid Dimorphos. The goal was to slow the space rock's nearly 12-hour orbit around a parent asteroid, called Didymos, and see if the momentum of the spacecraft could alter the asteroid's trajectory. The mission was successful, with Dimorphos's orbit shortening by 33 minutes in the weeks after the impact.

Teacher Jonathan Swift at Thacher School in California and his students used the observatory there to follow up the findings. The school's 0.7-metre telescope was powerful enough to observe these distant objects, and they found that the orbit of Dimorphos had shrunk by another minute more than a month after the collision (arXiv, doi.org/ksxf). "The number we got was slightly larger, a change of 34 minutes," says Swift. "That was inconsistent at an uncomfortable level."

His team presented its findings at a meeting of the American Astronomical Society in New Mexico in June.

The observations suggest something has caused the orbit of Dimorphos to continuously slow since the impact. One possibility is that the asteroid is now tumbling, having previously been tidally locked to Didymos. "That could cause tidal forces to change the orbital period," says Swift.

Harrison Agrusa, a DART team member at the Côte d'Azur Observatory in France, says there is some evidence for tumbling. "After the impact, it's significantly librating," he says, meaning that Dimorphos is wobbling in its position relative to Didymos,



NASA/ESA/STSCI/HUBBLE

Dimorphos after its collision with the DART mission

like the moon does with Earth. "Then it's possible, depending on inertia, this would evolve into more chaotic tumbling where it can flip around," he says.

However, Agrusa says this tumbling is unlikely to cause a shortening of Dimorphos's orbit, as the orbit would instead vary randomly. It is more likely that big rocks kicked up by the impact stayed in orbit near Dimorphos and later fell back to the surface, slowing its orbit more, he says.

Nancy Chabot, the coordination lead on DART at Johns Hopkins Applied Physics Laboratory in Maryland, says the DART team has continued to observe Dimorphos and will publish its own results in the coming weeks. Those also show the orbital period continued to decrease, albeit by a lesser amount, some 15 seconds, before plateauing, perhaps supporting the idea of ejected material continuing to hit the surface.

An upcoming European Space Agency mission called Hera, set to arrive at Dimorphos in 2026, could tell us for certain what happened after the impact, which may have implications for future attempts to redirect an asteroid.

"It's really good to know what we did to Dimorphos," says Chabot. "Those specific details are really key to applying this technique in future." ▮

Archaeology

Terracotta Army reveals secrets of ancient footwear

SHOES worn by the warriors of the first emperor of China, famously depicted by the Terracotta Army, may have been surprisingly flexible and slip resistant. Replicas of them are helping to build a better picture of what Qin dynasty soldiers wore and how this might have aided them in battle.

The Terracotta Army was found in 1974 near Xi'an, China, and is formed of more than 8000 sculptures depicting the armies of the founder of the Qin dynasty, Qin Shi Huang. The terracotta figures include warriors, chariots and horses and were buried alongside the emperor more than 2200 years ago to guard him in the afterlife.

Analysis of the sculptures has revealed what armour the ancient Chinese warriors wore and what weapons they used. Now, Na Cha and Jin Zhou at Sichuan University in China have recreated the shoes of one of the army's kneeling archers.



DAVID DAVIS/ALAMY

A kneeling archer from the sculpture army buried with emperor Qin Shi Huang

The pair determined that the archer's square-toed shoes had upturned tips and their soles were about 1.5 centimetres thick. There were also circular markings on the bottom of the soles, which the researchers took to represent stitches. There were more circles at the front and the heel, hinting that the real shoe was thinner in the middle, say Cha and Zhou.

The terracotta shoes resembled real shoes unearthed from the Qin dynasty, so the researchers used traditional shoe-making techniques from the time to recreate them.

They constructed the sole by overlaying layers of linen cloth and sewing them together using a fibre called ramie, which also made up the body of the shoes. They used denser stitches in the top and bottom thirds of the sole to replicate the circular markings.

The researchers also created replicas of other shoes found in the region and wore both types to test them. They found that the army replicas were more likely to bend during walking and were more slip resistant than the others. They were also more slip resistant in wet conditions than modern shoes with rubber or plastic soles (Research Square, doi.org/ksjj).

If the replica shoes truly reflect the real ones, they would probably have enhanced the soldiers' combat abilities, say Cha and Zhou. ▮

Chen Ly

The secret lives of numbers
Hear Timothy Revell reveal the history of maths on 8 October
newscientist.com/nslmag

Mathematics

More solutions to three-body problem

Record 12,000 ways found to solve fiendish puzzle of how three objects can stably orbit each other

Matthew Sparkes

THE question of how three objects can form a stable orbit around each other has troubled mathematicians for more than 300 years, but now researchers have found a record 12,000 orbital arrangements permitted by Isaac Newton's laws of motion.

While mathematically describing the movement of two orbiting bodies and how each one's gravity affects the other is relatively simple, the problem becomes vastly more complex once a third object is added.

In 2017, researchers found 1223 new solutions to the three-body problem, doubling the number of possibilities then known. Now, Ivan Hristov at Sofia University in Bulgaria and his colleagues have unearthed more than 12,000 further orbits that work.

The team used a supercomputer to run an optimised version of the algorithm used in the 2017 work, discovering 12,392 new solutions. Hristov says that if he repeated the search with even more powerful hardware, he could find "five times more".

> "The solutions to the three-body problem have a very beautiful spatial and temporal structure"

All the solutions found by the researchers start with all three bodies being stationary, before entering freefall as they are pulled towards each other by gravity.

Their momentum then carries them past each other before they slow down, stop and are attracted together once more. The team found that, assuming there is no friction, this pattern would repeat infinitely (arXiv, doi.org/ksxc).

Solutions to the three-body problem are of interest to astronomers, because they can describe how any three celestial objects – be they stars, planets or moons – can maintain a stable orbit.

It remains to be seen how stable the new solutions are when the tiny influences of additional, distant bodies and other real-world noise are taken into account.

"Their physical and astronomical relevance will be better known after the study of stability. It's very important," says Hristov. "But, nevertheless – stable or unstable – they are of great theoretical interest. They have a very beautiful spatial and temporal structure."

Juhan Frank at Louisiana State University says that finding so many solutions in a precise set of conditions will be of interest to mathematicians, but of limited application in the real world.

"Most, if not all, require such precise initial conditions that they are probably never realised in nature," he says.

"After a complex and yet predictable orbital interaction, such three-body systems tend to break into a binary and an escaping third body, usually the least massive of the three," says Frank.

Earth

Tonga volcano's eruption reshaped the seafloor

THE huge eruption of Hunga Tonga-Hunga Ha'apai volcano last year triggered a powerful underwater volcanic flow that destroyed hundreds of kilometres of telecommunications cables and reshaped the seafloor.

The blast in Tonga was the most powerful eruption of the 21st century, shooting ash 57 kilometres into the sky and causing 90-metre-high tsunami waves. "It was a really exceptional event," says Michael Clare at the National Oceanography Centre in Southampton, UK.

The eruption's effects on the atmosphere were well documented. "But something really profound had happened on the seafloor and we didn't know what it was," says Clare.

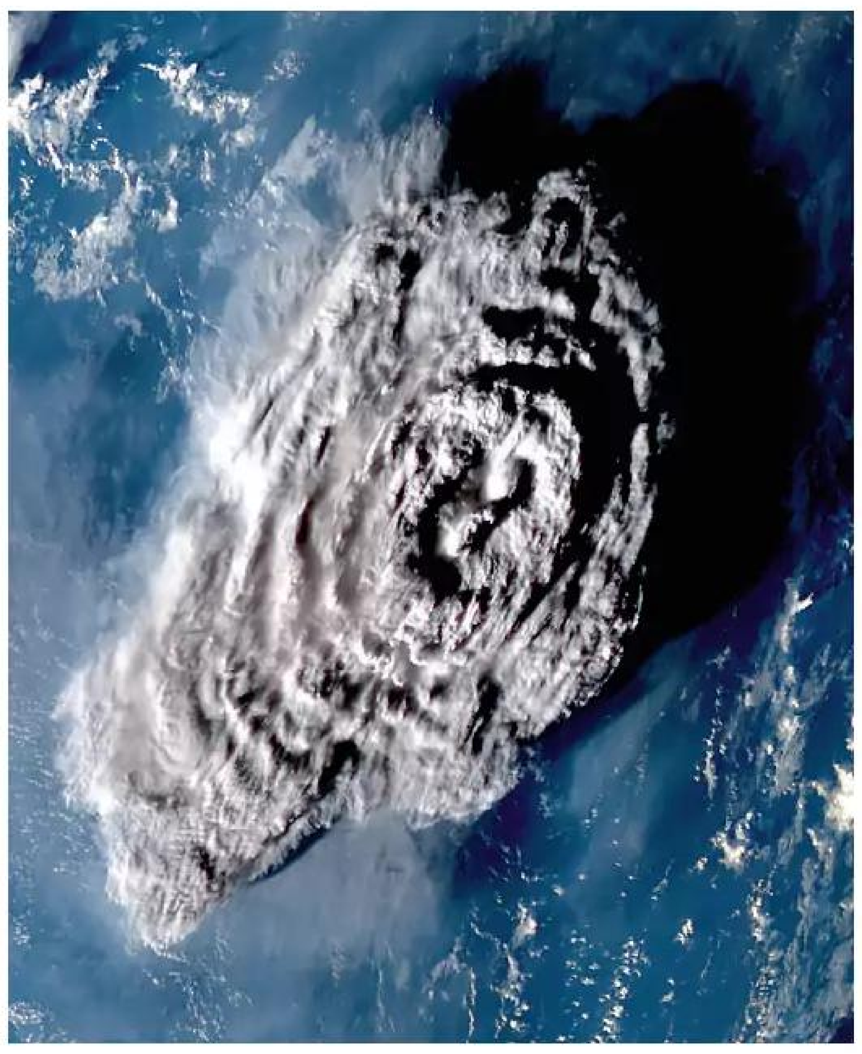
Soon after the explosion, Clare and his colleagues decided to investigate the eruption's impact on the bottom of the ocean.

Volcanic eruptions release a massive amount of material into the air, such as ash and lava. Some of this material quickly falls back down and forms what is known as a pyroclastic density current. "You'll have seen loads of videos of it – imagine big clouds of really hot rock rolling down hillsides," says team member Isobel Yeo, also at the National Oceanography Centre.

In the case of the Hunga Tonga-Hunga Ha'apai eruption, the material plunged straight into the ocean, producing a destructive underwater density current.

By mapping the locations of underwater telecommunication cables and when they were destroyed, the team calculated that the current must have travelled at 122 kilometres per hour.

The researchers also compared the map of the seafloor before and after the eruption and found that the density current travelled more than 100 kilometres across the bottom of the ocean, carving deep grooves (*Science*, DOI: 10.1126/science.adi3038).



S. PROUD/UNI OXFORD, RALSPACE NCEO/JAPAN METEOROLOGICAL AGENCY

Satellite photo of Hunga Tonga-Hunga Ha'apai volcano erupting on 15 January 2022

"This is the first time these underwater flows have ever been observed with modern technology," says Clare. "The insights from the study have helped us to determine a hazard which wasn't previously recognised as being potentially as big and significant as it is."

Although it is hard to prevent the damage caused by volcanic eruptions, a better understanding of any underwater density currents may help the telecommunications industry prepare for future events.

"The documentation of the impact of the Hunga-Tonga eruption to the seafloor geomorphology on the flanks of the volcano is a remarkable achievement," says Charles Paull at the Monterey Bay Aquarium Research Institute in California. "The paper will likely be highlighted in geology textbooks for generations, both as it serves as a reminder of the scale of geologic hazards and as an end member [extreme example] of the types of sediment flows that occur on Earth."

Chen Ly

Health

Covid-19 linked to higher risk of type 1 diabetes in children

Chen Ly

CHILDREN between 4 months and 2 years old who have had covid-19 are more likely to have antibodies that attack cells that make insulin, a feature of type 1 diabetes.

Insulin, a hormone that regulates the body's blood sugar levels, is made in the pancreas by cell clusters known as islets of Langerhans. In some cases, the body can develop an autoimmune response to these islets and produce autoantibodies against them. Too many of these over time will kill enough islets to trigger type 1 diabetes, where the body can't produce its own insulin.

"The presence of these autoantibodies more or less means that there's a 100 per cent path to [type 1 diabetes]," says Anette-Gabriele Ziegler at the Technical University of Munich in Germany.

One of the risk factors for type 1 diabetes is thought to be some viral infections, including SARS-CoV-2, the virus that causes covid-19. A rise in diabetes cases linked to covid-19 has been reported, but the mechanism behind it isn't known.

To investigate, Ziegler and her colleagues monitored 885 children between the ages of 4 months and 2 years old, who were all identified as having at least a small risk of developing islet autoantibodies. Of the cohort, 170 children had SARS-CoV-2 antibodies, suggesting they had previously had covid-19.

The children who had these antibodies were twice as likely to develop islet autoantibodies as those who hadn't been infected. Those who caught covid-19 before they were 18 months old had a 5 to 10 times higher risk of developing the autoantibodies – making them the most at-risk group (*JAMA*, doi.org/gspq8c).

"We would love to see if vaccinating children from 6 months can prevent the autoimmunity that leads to type 1 diabetes," says Ziegler. ■

Analysis Research and development

Can the UK's new science agency deliver moonshots?

The Advanced Research and Invention Agency has been tasked with a high-risk, high-reward approach, says **Thomas Lewton**



CHABYBUCKO/GETTY IMAGES

ARIA plans to take a new approach to science funding

THE UK's Advanced Research and Invention Agency (ARIA) has chosen eight scientists who will each be given up to £50 million to allocate as they see fit, in the hopes that a high-risk, high-reward approach to research funding will deliver results that benefit UK society and fuel economic growth. But will it work?

ARIA is the brainchild of Dominic Cummings, who advised former UK prime minister Boris Johnson and wanted to shake up science funding. "A small group of people can make a huge breakthrough with little money but the right structure, the right ways of thinking," he wrote in 2017.

Cummings was inspired by the US's Advanced Research Projects Agency (ARPA), which spurred computer science as a discipline and created a forerunner of the internet in the 1960s and 1970s. It did this, in the words of one of its leading scientists, by having "visions rather than goals" and because it "funded people, not projects".

Although Cummings is no longer in government, his plan is coming to fruition as ARIA announces its eight programme directors. Like ARPA, the new agency is focused on empowering "scientific talent" in ways that "can change the course of the future", says its CEO, Ilan Gur. "We were set up to focus on drastically improving the quality of life and economic growth in the UK."

It is unclear how this differs from existing government funding agencies, however. For example, UK Research and Innovation says its vision is to "build a thriving, inclusive research and innovation system that connects discovery to prosperity and public good". UKRI's £25 billion budget over three years dwarfs that of ARIA, which has an initial allocation of £800 million over four years.

£800m

ARIA's initial budget over four years

Perhaps then, the benefit of ARIA will come from the specific people it is investing in. The first cohort of programme directors are an eclectic bunch, often with experience working across disparate fields of scientific research.

Among them, medical physicist Gemma Bale plans to combine advances in imaging from astrophysics and biotechnology to create new ways of measuring human health, such as non-invasive brain monitoring. The same technology, she says, could even be used to monitor planetary health. "Could you then scale that up to image through the entire ocean?" she says. "ARIA's allowed me to think much bigger than I ever have as a scientist before."

Other programme directors include David Dalrymple, who wants to build artificial intelligence models that can safely be incorporated into real-world systems such as the UK's energy infrastructure, and Jacques Carolan, who wants to accelerate innovation in neuroscience, helping to understand and repair the human brain, using advances in physics and engineering.

Investment in diverse and exploratory ideas like these are a welcome addition to UK research funding, says Kieron Flanagan at the University of Manchester, UK. But he says that ARIA is "almost certainly sub-critical in size and unlinked from any of the scale effects that are really decisive in innovation".

Part of the halo around the US agency ARPA derives from its metamorphosis into the Defense Advanced Research Projects Agency in 1972 and, with it, funding by the large procurement arm of the US Department of Defense. How ARIA – which isn't military backed – will create the same technological pull isn't yet clear, says Flanagan. ■

Conservation

Huge project to release 2000 white rhinos across Africa

Ryan Truscott

A CONSERVATION group says it will rewild 2000 mostly captive-bred southern white rhinos (*Ceratotherium simum simum*), representing about 15 per cent of the total population of this species.

The rhinos were raised on an 8500-hectare ranch in South Africa owned by John Hume, a businessman who trimmed the horns off his live animals in anticipation of the international trade in rhino horn being legalised. It wasn't, and Hume, who hoped to sell the horns and use the income to fund conservation of the species, had to put his farm up for sale.

African Parks (AP), a conservation group that co-manages protected areas in a dozen African countries, has acquired Hume's rhino project, seen by some as one of the most successful breeding schemes for a threatened species.

> "As poaching has increased, the cost of conserving those rhinos has really skyrocketed"

AP says rehoming so many rhinos will represent "one of the largest continent-wide rewilding endeavours to occur for any species". Its CEO, Peter Fearnhead, says that once rewilded, the animals will "contribute to ecosystems by providing nutrient cycling, storing carbon and increasing tourism revenue for local people".

The group's intervention is "probably the best outcome", says Hayley Clements at Stellenbosch University in South Africa. "Hopefully they can progressively rewild those animals and do so into parks that are well managed so that they don't end up just getting poached."



ANN AND STEVE TOON/ALAMY

Some of the dehorned southern white rhinos set to be rewilded

Private owners like Hume play a critical role in protecting and expanding the southern white rhino population, which came close to extinction less than a century ago. In 2021, South Africa had 12,968 white rhinos, more than 80 per cent of the continent's total; just under 7000 of them were on private land. But poaching, which has led to steep declines of both white and black rhino (*Diceros bicornis*) in former strongholds like Kruger National Park, has made protecting them more expensive.

"As poaching has increased, the cost of conserving those rhinos has really skyrocketed to the extent that now rhinos in many cases become a liability, more than a benefit," says Clements.

Some question whether rewilding is the right term to use for Hume's animals. "The Hume rhinos contain a mix of wild-caught and captive-born animals, and a small proportion of captive-born animals of captive-born parents," says Dave Balfour at Nelson Mandela University in South Africa.

Depending on how they are released, the captive-born animals could learn from the wild-caught ones, he says. "Most people that I have spoken to, and myself, seem to think that they will generally do fine if they are released into appropriate habitat and with adequate available water of reasonable quality," he adds.

Fearnhead anticipates moving 300 animals per year to parks across Africa where there is suitable protection and sufficient grazing. "The overall vision is to establish a number of strategic populations across the continent, including establishing new founder populations or supplementing existing populations," he says. ■

New Scientist Live

The deep ocean's benefits

Hear Louise Allcock reveal how biodiversity helps us

newscientist.com/nslmag

Technology

Electrified mist could help capture carbon from power plants

Karmela Padavic-Callaghan

CARBON capture systems could become less expensive and more compact by using a mist of electrically charged droplets.

Simon Rufer at the Massachusetts Institute of Technology and his colleagues envision a carbon capture system in which flue gas from a factory enters a container filled with a mist of microscopic droplets of potassium hydroxide. The carbon dioxide in the gas reacts with these droplets to form droplets of water and potassium carbonate. These move to another part of the device with a high electric voltage, so they become charged. The charged droplets are then attracted to a collector electrode, from which they can be processed back into potassium hydroxide and reused.

Current carbon capture systems typically involve passing flue gas through towers up to 40 metres tall and 20 metres wide. The towers are filled with layers of metal mesh that are soaked with liquids that react with CO_2. In a presentation at the recent American Chemical Society fall meeting in San Francisco, Rufer said that based on the prototype he and his colleagues tested, they estimate that their design could be 95 per cent efficient at capturing CO_2, while measuring less than 4 metres long. This is because the surface area of the droplets in even a small volume of mist is vast, providing a greater area for reactions than solid meshes do.

Rufer said the approach would reduce the costs of adding carbon capture to power plants by about 2.6 times compared with current technology.

"For a typical plant, you are looking at something that's going to cost three-quarters of a billion dollars, so anything that you can do to bring the cost down is going to help," says David Heldebrant at Pacific Northwest National Laboratory in Washington state. ■

Human history

Cave art pigments show how ancient technology evolved

Michael Marshall

A HUGE stash of reddish minerals from a cave in Ethiopia shows how Stone Age people gradually adapted their technologies and practices over a 4500-year period.

"It's one of the rare sites where we can see a very precise evolution of this cultural feature through thousands of years," says Daniela Rosso at the University of Valencia in Spain.

She and her colleagues studied materials from Porc-Epic cave in Ethiopia. The cave first became known to scientists in the 1930s and was excavated in the 1970s. It was used by people in the Middle and Late Stone Age, between about 80,000 and 40,000 years ago, but the bulk of archaeological material dates from a 4500-year-long period about 40,000 years ago.

This material included 4213 pieces of "ochre", a term for minerals that are rich in iron and so have vivid colours, typically red. Prehistoric people often collected these minerals, but the original excavators of Porc-Epic didn't study them. "This is the first time there is a systematic study of ochre use at this site," says Rosso.

The researchers found that ochre from the beginning of the 4500-year period was typically high quality and rich in iron, and ochre from the end of the period was lower quality and had less iron. Later ochre was also coarse-grained, so instead of grinding it to powder, the people tended to chip and cut it (*Scientific Reports*, doi.org/ksw6).

"They can really trace several thousands of years of behavioural change"

There are several possible explanations for the shift. One is that the people at Porc-Epic may have been using the ochre for different purposes as time went on and chose different types accordingly.

The most famous use of ochre is as a pigment for artworks, but Rosso says it was probably sometimes used in utilitarian ways – for making adhesives, or as sunscreen, for example.

However, running counter to the idea that the shift was deliberate is a 2022 study by Rimtautas Dapschauskas at the University of Tübingen in Germany and his colleagues. They reviewed all known uses of ochre in Africa from 500,000 to 40,000 years ago. Dapschauskas says prehistoric people consistently sought out "fine-grained and blood-red materials", which were the best for pigment as they could be ground to a very fine powder and produced vivid colours. "People really, really preferred those reddish colours," he says.

So it may be that, as time passed, the people at Porc-Epic simply found it more difficult to source the best ochre. Rosso and her colleagues examined local geological deposits and found that the available ochres didn't match those in the cave: they were often coarser-grained and had less iron. "Probably they had to go further away" to find the best ochre, says Rosso.

Why it became harder to get high-quality ochre is unclear, says Dapschauskas, but it may be that the social situation changed: for instance, if the people at Porc-Epic relied on trade to secure the best ochre, then conflict with neighbouring groups might have led to shortages.

The study adds nuance to our understanding of technological stasis in the Stone Age, says Dapschauskas. "There's a form of stability," he says. "The cultural knowledge is transferred from generation to generation." But the people were also flexible and changed their practices, he says. "They can really trace several thousands of years of behavioural change." ▮

Porc-Epic cave, Ethiopia, where thousands of bits of ochre were found



A. HERRERO

Zoology

Salamander eggs hatch more easily if nibbled by predators

Jake Buehler

SPOTTED salamander embryos are more likely to hatch if there are predators around to help them along. The salamanders (*Ambystoma maculatum*) lay their eggs in pools where they are often eaten by predators like wood frog (*Lithobates sylvaticus*) tadpoles.



E.R. DEGGINGER/ALAMY

Spotted salamander embryos can struggle to get enough oxygen inside their eggs

For protection, the egg masses are cloaked in layers of jelly. However, this makes it harder for developing embryos to get enough oxygen.

Because egg masses can die in low-oxygen conditions, Mizuki Takahashi and Dominique Ruszala at Bucknell University in Pennsylvania decided to investigate what was going on. They gathered 32 salamander egg masses from pools in Pennsylvania and either removed or kept the thick jelly layers. They placed them in containers and added either 0, 50, 100 or 200 tadpoles.

The eggs stripped of jelly were all eaten in conditions with high levels of tadpoles. But without any predators around, more eggs survived when the jelly coats were removed: over 90 per cent compared with the intact eggs' 72 per cent. Intact eggs survived better when they were with the most tadpoles (*Ecology and Evolution*, doi.org/ksw5).

"It would make sense for the thick jelly layers to naturally thin over time to improve oxygen supply," says John Gould at the University of Newcastle, Australia. Yet the jelly thinning is done by predators, showing how intimately linked predators and prey are, he says. ▮

Technology

Smart toilets could leak your medical data, warn security experts

Matthew Sparkes

TOILETS with built-in gadgets that monitor your health are poised to make a splash in the world of wellness tech – but they come with risks of data leaks and medical misdiagnosis, warn security experts.

A range of start-ups and research projects have developed smart toilets to monitor everything from heart rate to the consistency of stools and the presence of certain proteins in urine that indicate disease. One device even features an "anus camera" that takes a photo from below for identification, something that has been described as the "polar opposite of facial recognition".

"If you just have a medical hat on, they sound fantastic, but I have a professional privacy hat on," says Isabel Wagner at the University of Basel, Switzerland.

Wagner and Eerke Boiten at De Montfort University in Leicester, UK, recruited a panel

"If you have a medical hat on, they sound fantastic, but I have a professional privacy hat on"

of three anonymous privacy experts and asked them to imagine scenarios in which smart toilets backfired. All three expressed serious reservations.

One concern was the privacy of people other than the owner: are visitors consenting to have photographs or measurements taken? There were also worries about the risk of losing sensitive data to hackers, as well as the possibility of companies selling the data on. And if smart toilets were installed in public areas or workplaces, there would be questions about who has access to that data, it was argued.

There were also practical concerns, such as who would be liable if a medical condition were missed, or if false positive diagnoses unnecessarily sent people to doctors, perhaps leading to invasive tests.

The group of experts concluded that smart toilets shouldn't be sold as consumer devices, but instead as medical devices that have to meet high regulatory standards for privacy and safety (arXiv, doi.org/ksx5).

Chase Moyle at smart toilet start-up Coprata says he set out to build a consumer device because creating a medical device under US Food and Drug Administration regulations would raise the price by a factor of 10. It would also mean that, in the US, insurance companies would only offer it to people with diagnosed conditions.

"We think that we're passing up way too much of the population size if it's only a medical device," says Moyle.

He says the firm follows best practice on data security. It aims to create a consumer device first before later making a medical device and eventually collecting anonymised data to help researchers working on digestive diseases and nutrition. "No one else has captured this data before on a recurring basis," says Moyle.

Alan Woodward at the University of Surrey, UK, says so-called internet of things (IoT) devices, such as heart rate monitors and CCTV cameras, have often been found to have security flaws, including a smart toilet with a computer-controlled bidet. He fears the same could be true for medical-focused smart toilets. "With a lot of IoT devices, security has never been uppermost in the mind and yet something like a smart toilet is collecting some very personal data," he says. "They're making these weird devices because they can, but nobody's thought through 'should we?'"



MYBOYS.ME/SHUTTERSTOCK

Tech-enhanced toilets could reveal details about your health – to you and to others

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Palaeontology

Ancient koala may solve mystery of marsupial evolution

Sofia Quaglia

A MINI koala that lived in central Australia about 25 million years ago could provide insight on the evolution of marsupials.

The species (*Lumakoala blackae*) is represented by just a dozen ancient teeth, found in fossil-bearing rocks near Alice Springs.

"Teeth are good because they provide a huge amount of evolutionary and dietary information," says Arthur Crichton at Flinders University in Australia. Analysis of those teeth by Crichton and his colleagues suggests that *L. blackae* weighed between 2.2 and 2.6 kilograms – much smaller than the modern koala (*Phascolarctos cinereus*), which weighs 4.1 to 13.5kg. It probably ate relatively soft plant material, like young leaves and small fruits, rather than the tough eucalyptus leaves that today's koalas eat.

Other fossil teeth found in the area reveal that *L. blackae* shared its environment with many other prehistoric koala species (*Scientific Reports*, doi.org/gsn837).

The discovery sheds some light on a 30-million-year gap in Australia's fossil record that runs from 55 million to 25 million years ago, when fossils of modern marsupial groups – such as kangaroos, possums and koalas – suddenly appeared. "What the heck happened in between?" says Gilbert Price at the University of Queensland in Australia. Although *L. blackae* comes at the end of that gap, it shares characteristics with other non-koala marsupials today, says Price. So it could represent a species closer to what Australia's previously very diverse marsupial communities evolved from.

"Diversity across so many marsupial groups has dwindled dramatically," says Price. "Today is the first time in the past 25 million years that there is only one koala species present."

Health

Human kidneys partially grown in pigs offer transplant hope

Alice Klein

KIDNEYS that are more than 50 per cent human have been partly grown in pigs for the first time.

The research, conducted by Miguel Esteban at Guangzhou Institutes of Biomedicine and Health in China and his colleagues, brings us a step closer to being able to grow human kidneys in other animals to address the shortage of organ donors. Over 100,000 people in the US alone are currently waiting for a kidney transplant, with 13 dying per day.

To get around the need for donors, it may be possible to grow human kidneys in other species with similar organ sizes and physiology to us. Esteban and his colleagues explored this idea by creating pig embryos that couldn't form kidneys of their own, by disabling two key genes involved in the development of the organs.

Next, they introduced human stem cells into the pig embryos, hoping they would transform into kidney cells in the animals and assemble into the relevant organs. The human cells were genetically engineered to help them integrate in the foreign environment by increasing the expression of two pro-survival genes.

1800+

Number of pig-human embryos implanted in sows

The researchers implanted more than 1800 of these hybrid embryos in the reproductive tracts of 13 sows. They only allowed the embryos to grow for 25 to 28 days before removing and analysing them because of various ethical considerations, including the possibility of producing pigs with human-like brains if the human cells spread beyond the kidneys.

Only five of the embryos successfully implanted, but these developed early kidney structures, including miniature tubules, that were made of 50 to 65 per cent human cells and the rest pig cells.

"This is a very important study," says Jun Wu at the University of Texas Southwestern Medical Center. Wu and his team reported the creation of the first human-pig embryos in 2017, but were only able to incorporate a very small proportion of human cells, which didn't assemble into organs.

Esteban and his colleagues tracked where the human cells went in their embryos by tagging them with a red fluorescent marker. Very few became incorporated in the early central nervous system or other organs, which Wu says is reassuring (*Cell Stem Cell*, doi.org/ksjh).

The researchers in China have now received approval from their institute's ethics committee to let such human-pig embryos develop for up to 35 days to see if the humanised kidneys continue to mature properly and to ensure minimal human cells end up in other organs. "We will move forward step by step," says Esteban. They are also looking at growing other human organs like the heart and liver in pigs, he says.

Other groups are trying pig-only organs for transplants. On 14 July, for example, surgeons at NYU Langone Health in New York transplanted a pig kidney into a brain-dead man. This came from an animal that had a gene knocked out so its organs wouldn't trigger an immune reaction in a recipient.

Wu believes that a combination of both of these approaches – growing kidneys that are mostly human in pigs and also knocking out genes that might trigger immune reactions – may end up working best.

Invasive species

Red fire ants with painful bites have taken hold in Europe

DOZENS of red imported fire ant nests have been found in Sicily, Italy – a sign that the invasive insects have become established in Europe.

The red imported fire ant (*Solenopsis invicta*) is a venomous species that originally comes from South America.

Since it was first described by science in 1916, the species has spread around the world, including to Australia, China and the US, primarily due to imports of soil and plants from its native region to other countries.

"It's considered one of the worst invasive species," says Mattia Menchetti at the Institute of Evolutionary Biology in Barcelona, Spain. For people, red fire ant bites can be extremely painful due to their venom, which some people may even be allergic to, he says.

Red fire ants also pose a threat to nature by preying on other species, such as birds and reptiles, and displacing native ant species.

Local reports of painful ant stings from around the coastal city of Syracuse on the island of Sicily have been circulating for a few years, says Menchetti.

He and his colleagues went to collect some of the ants responsible for the bites and quickly identified them as *S. invicta*. The team found a total of 88 red imported fire ant nests spread over 4.7 hectares in the area.

DNA from these ants was found to be most similar to red imported fires ants in China and the US – a clue that the now-established Sicily population may have come from either of those countries.



FLORIDA IMAGES/ALAMY

Red imported fire ants are an invasive species in many parts of the world

According to the team's models, the ants could spread to 7 per cent of Europe under current environmental conditions, although climate change could increase their range further. They are most likely to spread to warm, well-connected regions, such as coastal Mediterranean cities.

But urban areas across the continent, including Paris and London, may be suitable for the species to thrive because of their many heat sources, such as buildings (*Current Biology*, doi.org/kszn).

Menchetti's team is working with authorities to continue monitoring the region and to establish the extent of the population, which will help guide eradication plans.

Chen Ly

Artificial intelligence

GPT-4 wins chatbot lawyer contest

AI chatbots have gone head to head on legal reasoning, but none can match real lawyers yet

Jeremy Hsu

LANDMARK chatbot GPT-4 has beaten other artificial intelligence models on a test of legal reasoning, but it still falls short of the skills required by lawyers. Some early attempts to use AI chatbots in court have been disastrous, and this latest finding adds evidence that AI isn't ready to handle real-world legal tasks.

Neel Guha at Stanford University in California worked with AI researchers and lawyers to design LegalBench, which evaluates how well AI chatbots can deal with six different types of legal reasoning. LegalBench includes 162 practical tasks that human lawyers must handle in everyday practice, such as correctly analysing legal documents and detecting different types of legal language.

That makes LegalBench more relevant to how lawyers work than seeing if an AI can memorise the information needed to pass a bar exam that lawyers take to qualify, says Guha. GPT-4 has already shown it can outperform the average bar exam test taker with a score of 75 per cent.

Guha and his colleagues used LegalBench to evaluate 20 commercial and open-source large language models, including OpenAI's GPT-4 and GPT-3.5. GPT-4 generally performed the best with scores in the 70s and 80s out of 100. However, it performed poorly on recalling the specifics of legal rules, scoring just 59. GPT-3.5, Anthropic's Claude and Meta's Llama models generally trailed behind (arXiv, doi.org/kshx).

"I think the expectation is that a human legal professional trained for the task should get close to perfect on the majority of LegalBench tasks," says Guha. "Unfortunately, we haven't had the chance to evaluate a human legal professional on these tasks."

Providing an independent, comparative ranking of AIs is likely to be useful for law firms and legal teams, says Tom Roberts, a partner at law firm Allen & Overy.

Since February, his company has been testing how well OpenAI's generative AI technology – customised by the company Harvey – can research legal topics and draft emails. The greatest challenges in adopting AI have to do with the costs, risk management and information security for proprietary data, but also how such technologies handle more complex legal reasoning, says Roberts.

Given the "significant limitations" of AI, the law firm has been careful to "place clear limits on the technology's use and always have a human in the loop", says Roberts.

AI chatbots may still give inaccurate answers when asked to provide information about specific cases, laws or regulations, says Guha. In one real-life example, a US judge fined lawyers for submitting materials based on non-existent legal cases that were made up by ChatGPT.

The use of AI chatbots in the legal profession also raises questions about unauthorised practice of law, copyright issues, legal malpractice and who can access such legal help, says Guha.



Artificial intelligence is increasingly being used by lawyers

WESTOCK PRODUCTIONS/SHUTTERSTOCK

Health

Westerners sleep later on weekends than people in Asia

WESTERNERS are more likely to go to bed earlier and have longer lie-ins at the weekend than people in Asia, which could have health impacts.

Michael Chee at the National University of Singapore and his colleagues analysed data from 220,000 people in 35 countries using sleep trackers between January 2021 and January 2022. Most of the countries were either Western or Asian and there were, on average, 242 nights of data for each wearer.

Overall, across all countries, people slept longer on the weekend than during the week and woke up 30 to 60 minutes later. But those in Asia tended to have shorter lie-ins than the typical Westerner.

People in India had the shortest weekend lie-ins, at some 3 minutes longer than their weekday sleep, and those in Finland had the longest, with about 27 extra minutes (*Sleep Medicine*, doi.org/kswp).

Chee says that, in many Asian countries, weekend days aren't culturally the same as weekend days in the West. "They're not really a rest day," he says.

The researchers also found that people in Asia typically went to sleep later and slept less on weekdays than people in the US and Europe. On average, people in Asia slept about 45 minutes per day less than people in other parts of the world. "Work times are roughly the same across the world, so if you go to sleep later, you're going to get less sleep," says Chee.

"Weekend days in many Asian countries aren't culturally the same as weekend days in the West"

There is no evidence that people in Asia need less sleep than those in the West, says Chee; instead, the results reveal how culture affects sleep practices.

He says that although the sleep data was collected during the covid-19 pandemic, the trends are likely to be similar today.

As disturbed sleep affects quality of life and long-term health, it will be crucial to explore the effects of these differences in sleep patterns, says Victoria Pak at Emory University in Atlanta, Georgia.

Jason Arunn Murugesu

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Technology

Quantum batteries could perform better if charged wirelessly

Karmela Padavic-Callaghan

WIRELESS charging could make quantum batteries work more effectively and last longer.

Quantum batteries are a largely theoretical form of energy storage that could charge quickly thanks to quantum effects. But they would be susceptible to disturbances, which means they could spontaneously lose charge or undergo "ageing" – losing efficiency, much like a smartphone's battery life drops.

Now, Jun-Hong An at Lanzhou University in China and his colleagues have devised a new charging procedure. Instead of starting with a quantum battery and its charger physically touching one another, they modelled what would happen if each were placed in a different part of a "waveguide" – a thin, metal tube with a rectangular cross-section. They also assumed that the waveguide would be filled with an electromagnetic field.

The researchers used quantum theory to derive equations describing how the battery's energy would change over time, essentially how it would charge wirelessly.

An says the quantum effects that make quantum batteries work are fragile, so it would be reasonable to expect that the physical distance and electromagnetic field would disturb those effects.

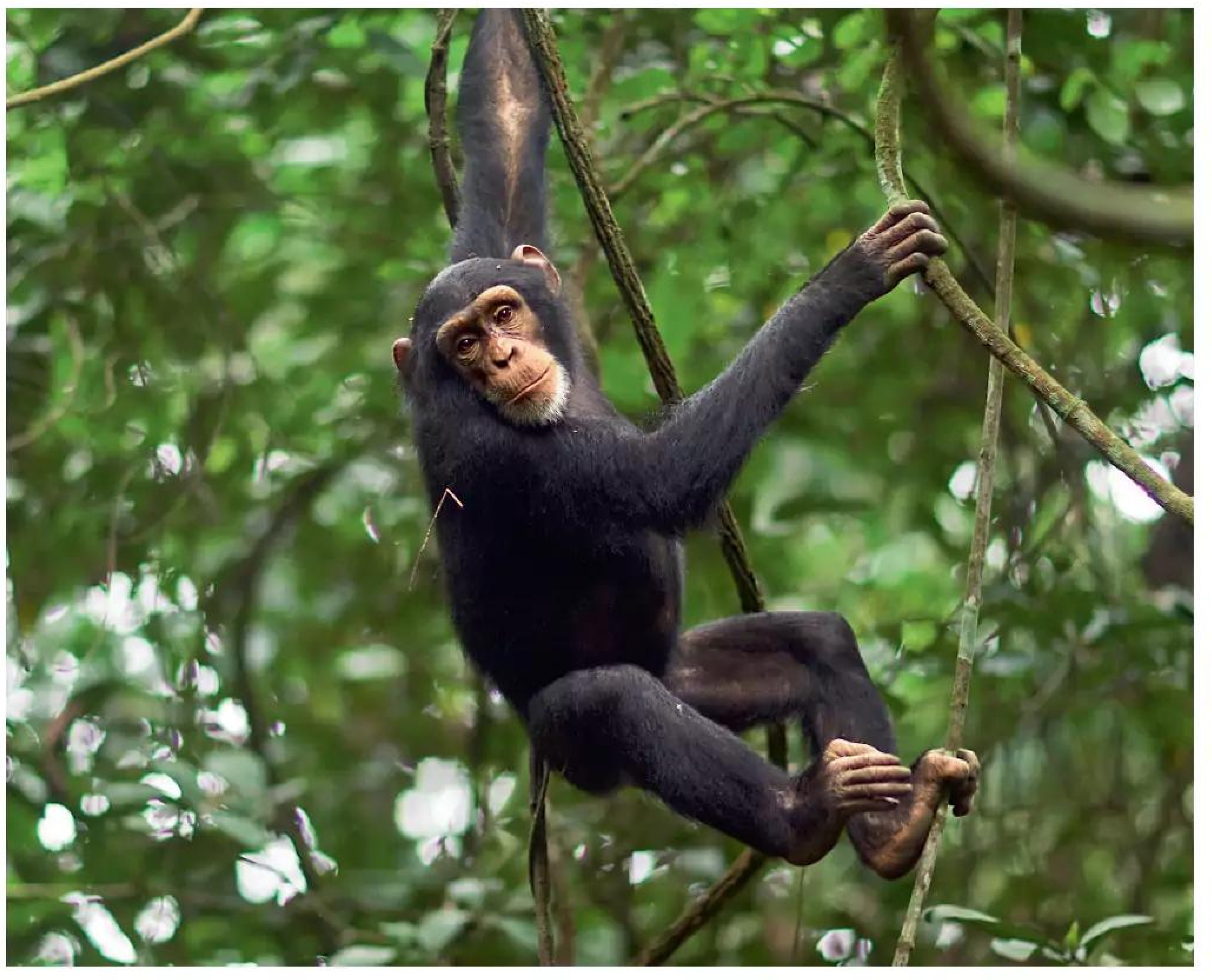
But his team's calculations suggest the opposite. He says the battery and charger interacting with the same electromagnetic field "induced ideal charging" and the quantum battery became "immune to ageing" (arXiv, doi.org/ksc9). He likens it to two people swimming in a lake being caught in the same waves.

The design is feasible for simple batteries because similar waveguides are used in experiments, but it may not work for more complicated batteries, says Karen Hovhannisyan at the University of Potsdam in Germany. ▮

Human evolution

Our mobile arm joints may have evolved for climbing down trees

Christa Lesté-Lasserre



ANUP SHAH/NATUREPL.COM

Chimpanzees' shoulders and elbows have a large range of movement

HUMANS' advanced ability to throw things may have started with having evolved shoulders and elbows that stopped our ancestors from falling as they climbed down trees.

Bulkier and heavier than agile monkeys, humans and other great apes can be proficient upward climbers, but struggle to climb back down safely. To counteract the pull of gravity as primates' body shapes evolved, arm joints became more flexible, allowing apes to stretch away from trees while climbing down so that their feet could brake more efficiently, says Nathaniel Dominy at Dartmouth College in New Hampshire.

"Going downward is much more challenging than going upward because you have to carefully dissipate that potential energy that would cause you to fall," he says.

Humans and other apes have a greater range of motion in their shoulders, elbows and wrists than monkeys. Scientists originally suspected that these differences evolved to help prevent falls in the heavier primates as they climbed up trees. But that idea has been hard to prove, since wild chimpanzees use their arms much like monkeys do, with similar shoulder and elbow angles, as they climb up.

Dominy and his colleagues wondered if it might have more to do with climbing downwards,

> **"Going downward when climbing is much more challenging than going upward"**

because they had spotted that chimpanzees' upward climbing style was markedly different to their downward style.

To investigate further, they filmed wild chimpanzees (*Pan troglodytes*) in Uganda for six weeks and wild sooty mangabeys (*Cercocebus atys*), a kind of monkey, in Ivory Coast for four months. Using sports analysis and statistical software on their video stills, the researchers measured the angles of the animals' shoulders and elbows while they climbed. They also examined the arm anatomies of both species from preserved skeletons.

They found that, when climbing up, the monkeys and apes had similar shoulder and elbow angles. But when they were climbing down, chimpanzees flexed their shoulders 21 degrees more and their elbows 33 degrees more than the mangabeys did. Anatomical analyses confirmed that the apes' shoulders and elbows allowed greater rotation and flexibility (*Royal Society Open Science*, doi.org/ksc7).

Wider joint angles allow apes to hold their bodies further away from the tree, thereby pressing their weight against the trunk with their feet rather than slipping against the trunk towards the ground, says Dominy.

"It's sort of like finding the piece to a puzzle that you've been looking for and then realising it was right in front of you all along," says Susan Larson at Stony Brook University in New York.

The findings prompt a "chicken or egg" question, she says. "Did this range of motion of the elbow and shoulder allow apes to become larger-bodied, or were they large-bodied and then this gradually developed?"

These rotation and extension abilities would lead to additional skills, says Dominy. In particular, humans would later be able to use their arms for gathering fruit, wielding weapons and eventually tossing balls and using ladders. The price we pay is that our flexible joints make our shoulders more prone to dislocation, he says. ▮

Climate change

Earth has just seen its hottest three months on record

Alec Luhn

OUR planet has just experienced its hottest three-month period on record. The global average temperature for June, July and August was 16.77°C (62.19°F), a whopping 0.66°C above average, according to the European Union's Copernicus Climate Change Service. That temperature beat the previous record set in 2019 by almost three-tenths of a degree.

"Our climate is imploding faster than we can cope with extreme weather events hitting every corner of the planet," said António Guterres, secretary-general of the United Nations, in a statement. "Surging temperatures demand a surge in action."

> "2023 is likely to be the warmest year that people have ever experienced"

Last month was the hottest August in records going back to 1940 and the second hottest month ever after this July, when the average global temperature was 16.95°C (62.51°F). Ocean temperatures have been even warmer, averaging 20.98°C (69.76°F) in August – the new hottest month on record. July and August were both estimated to be 1.5°C above the pre-industrial average, temporarily reaching the limit on yearly average warming established by the Paris Agreement.

The average for the year to date is only 0.01°C behind 2016, the hottest year on record, with El Niño, a periodic build-up of warm water in the eastern Pacific, expected to keep boosting global temperatures.

"2023 is likely to be the warmest year people have ever experienced," says Samantha Burgess at the Copernicus Climate Change Service, adding that temperatures will continue to rise over the next decade.

Neuroscience

New type of cell is discovered in the brain

Jason Arunn Murugesu

A PREVIOUSLY unknown brain cell, called a glutamatergic astrocyte, has been discovered. It could explain how a variety of neurodegenerative conditions develop, such as Parkinson's.

Brain cells can largely be categorised into two types: neurons and glia. The former typically communicate with each other across the synapses, or junctions, between them.

This so-called synaptic transmission occurs when a neuron is electrically excited and releases a chemical, called a neurotransmitter, into the gap between itself and another neuron, which activates the second neuron.

This ability was largely thought to be unique to this type of brain cell. But two decades ago, Andrea Volterra, now at the University of Lausanne in Switzerland, and his colleagues announced that they had discovered that some glia could also use synaptic-like transmission. However, the findings proved controversial as other researchers struggled to replicate the findings.

Now, Volterra and a different team have used modern techniques to finally put this controversy to bed.

The researchers analysed data on the production by genes in mouse cells of RNA molecules, which are intermediates in protein production, to see if they could find the protein complexes required for synaptic transmission in cells other than neurons. The team specifically looked at cells in the brain's hippocampus region, because this is where the previous research claimed to have spotted non-neuronal synaptic transmission.

The analysis revealed several clusters of astrocytes, a type of glia, that appeared to also possess the ability to take part in synaptic transmission. The cells seemed to release the neurotransmitter glutamate, which is the most common neurotransmitter in the brain. Volterra and his colleagues then confirmed the presence of the genes involved in this by studying brain slices from adult mice. They have dubbed these cells glutamatergic astrocytes (*Nature*, doi.org/ksct).

"These cells are a little bit like astrocytes and a little bit like neurons," he says. "They are secreting neurotransmitters with a mechanism and speed that are usually only linked to neurons. It's why we call it a kind of hybrid cell."

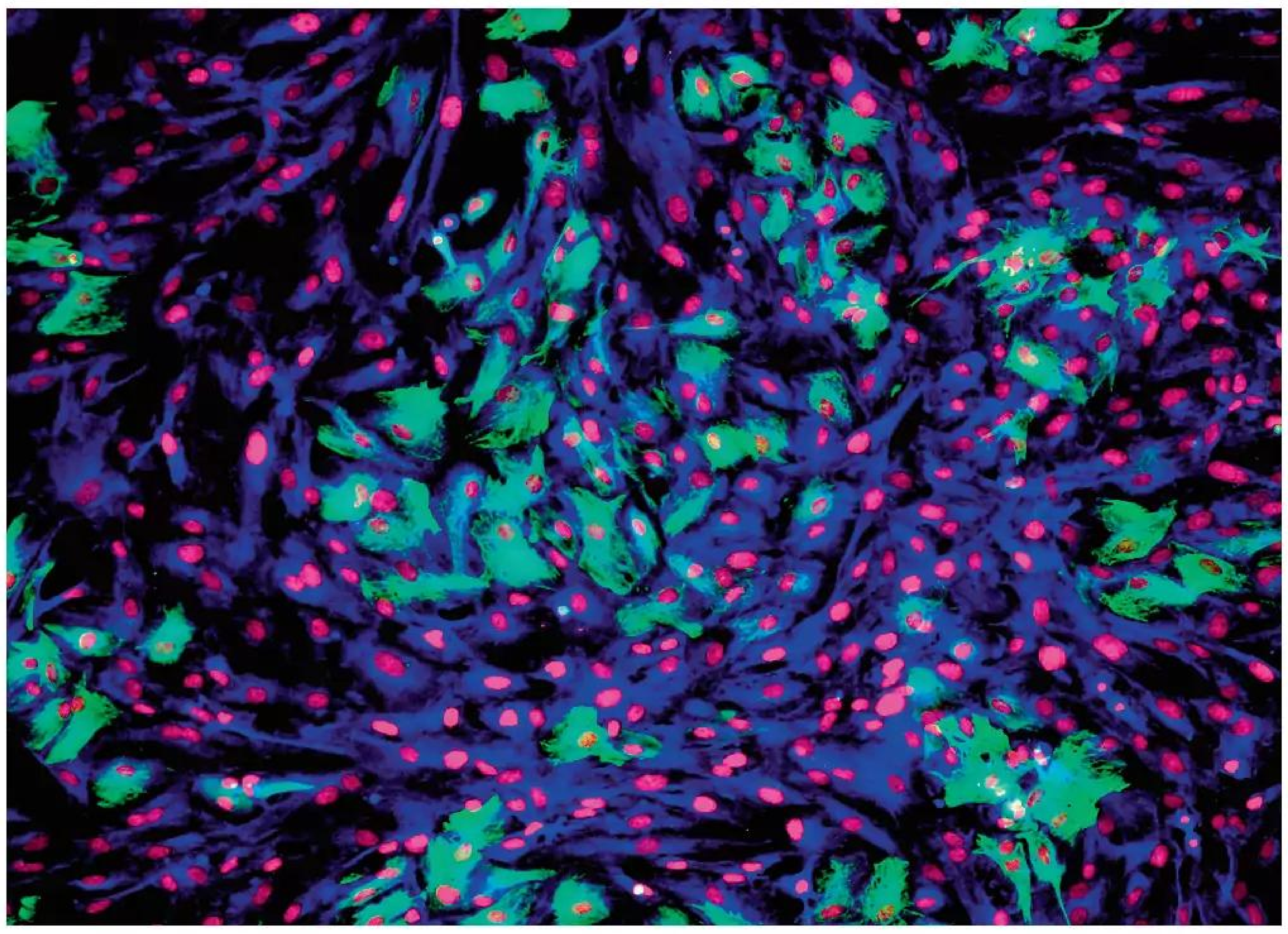
The researchers then used a type of fluorescent microscopy to study glutamate release by these cells in the brains of the mice. "The signals that we see are in the order of speed similar to neurons," says Volterra.

He and his colleagues found similar protein signatures of synaptic transmission in human non-neuronal cells by looking at existing data sets. "The findings suggest that these cells are conserved [in people]," says team member Ludovic Telley, also at the University of Lausanne.

Volterra speculates that having glia that communicate via synaptic transmission could lead to a greater coordination of brain signals. This is because while neurons can be connected to thousands of other neurons, astrocytes can be in contact with 100,000 synapses in mice, or millions of them in humans.

The glutamatergic astrocytes also seem to be in brain circuits involved in movement, which degenerate in Parkinson's disease, says Volterra. A better understanding of the cells could help us tackle the condition, he says.

In the brain, some groups of astrocytes, like these, seem to send messages



RICCARDO CASSIANI-INGONI/SCIENCE PHOTO LIBRARY

Building a brain in a dish
See Selina Wray speak at New Scientist Live on 8 October
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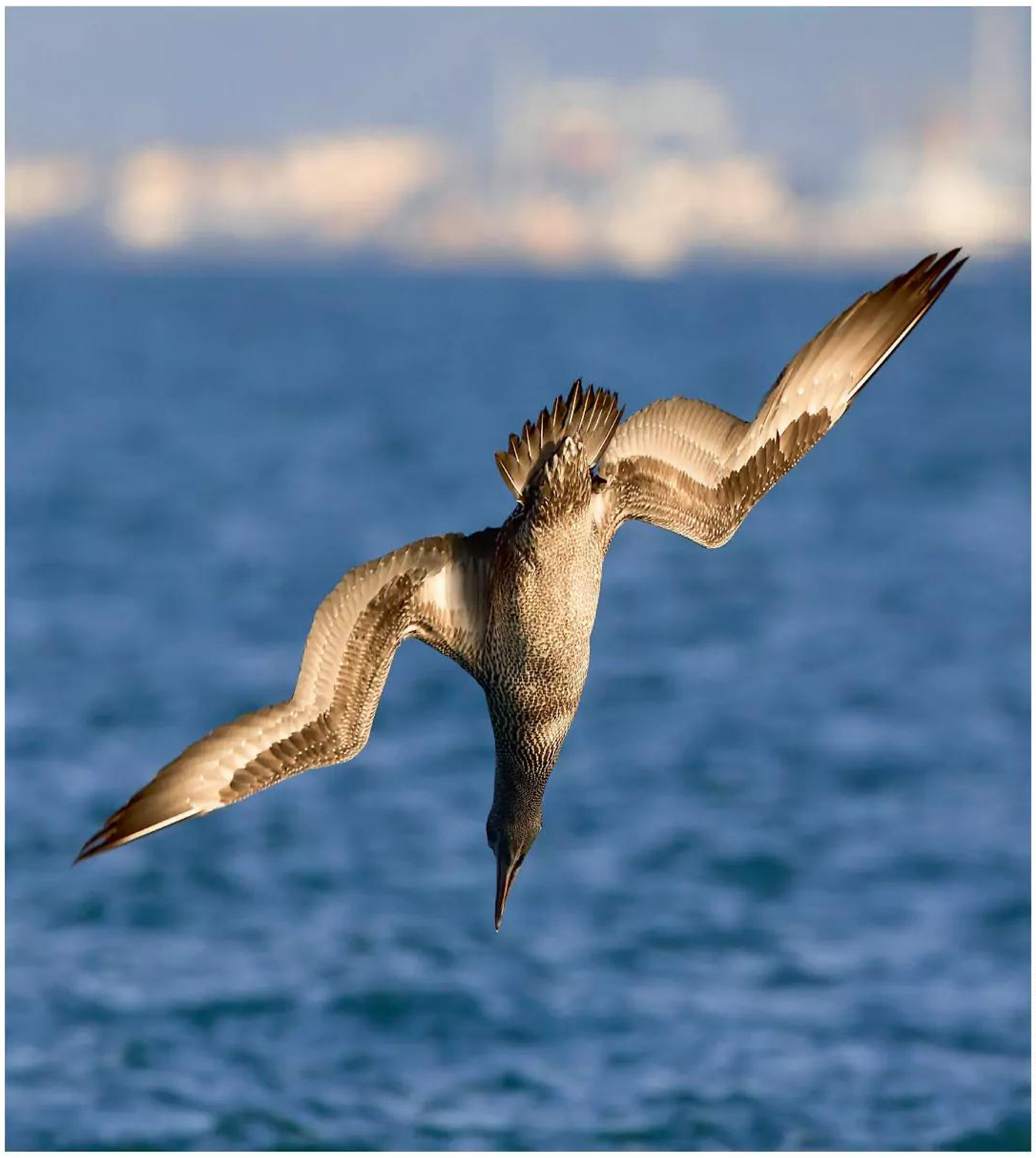
Human history

Ancient stones were deliberately rounded

AN ANALYSIS of 150 baseball-sized stones found at a site where early humans lived 1.4 million years ago shows that they were intentionally knapped into spheres.

Antoine Muller at the Hebrew University of Jerusalem and his colleagues scanned 150 limestone balls known as spheroids, all about 8 centimetres in diameter. They were from 'Ubeidiya, a site in what is now northern Israel thought to have been used by some of the first members of our ancestor species *Homo erectus* to leave Africa.

The researchers worked out the sequence of strikes responsible for each ball's shape, and they say making them required similar levels of skill as making hand axes (*Royal Society Open Science*, doi.org/ksdn). How they were used is unknown, but they might have been projectiles. **Michael Le Page**



BUITEN-BEELD/ALAMY

Technology

A heartbeat helps pumps be efficient

RHYTHMIC pumping inspired by the human heart could slash the energy needed to force fluids like oil or water through pipes.

Pumping fluids through pipes is estimated to use 10 to 15 per cent of the world's electricity, partly because friction, caused by turbulence, means more energy is needed for pumping.

Now, Björn Hof at the Institute of Science and Technology Austria and his colleagues have pumped water containing reflective particles through transparent pipes so they could see the swirls and eddies as they used different patterns of pulses. Most patterns increased the energy required, but having a short resting phase between pulses – like that between heartbeats – reduced turbulence. One rhythm cut energy demand by 9 per cent (*Nature*, doi.org/ksdp). **Matthew Sparkes**

Zoology

Gannets prefer to roll either right or left when diving

WHEN gannets dive into the sea to catch fish, they roll either to the left or right according to their individual preference, much like how most people have a dominant hand.

The preference for one side of the body over the other, or laterality, occurs in lots of animals. Many primates, like humans, have a dominant hand and cockatoos tend to be left-footed, for example.

Ashley Bennison at the British Antarctic Survey and his colleagues attached accelerometers to 71 northern gannets (*Morus bassanus*) on the coasts of Ireland and Wales and tracked their movements for roughly three days. The birds had 3 to 4-week-old chicks, so needed to hunt at sea every day.

When gannets spot their prey, they roll to one side before plunging into the water. The accelerometers recorded 2133 dives by 51 birds. Of this group, 22 would consistently roll to the right during their dives, 26 would roll to the left and three had no preference. The gannets also had a preferred dive angle, although this didn't seem to predict whether they rolled left or right (*Biology Letters*, doi.org/ksdm).

In contrast to us, gannets seem to be fairly evenly split between left and right-handers. It isn't clear why most people are right-handed, but some researchers think it is due to social factors.

"When you look at humans, we are predominantly right-handed and that allows us to sort of coordinate an easy life in terms of tool use," says Bennison. "When you see a more even split, like we've got here, it means it's a behaviour that has come about because the individuals are engaging in more complex tasks by themselves." **Chen Ly**

Really brief



ANTONI GANDIA 2023

A Terminator with living fungus skin

Researchers inspired by 1984 film *The Terminator* have grown a living skin made from a fungus called *Ganoderma sessile* on an 18-centimetre-tall Terminator model. The skin can sense light and touch, so could be useful as a biodegradable sensor for electronics (Research Square, doi.org/kshp).

Huge star explosion faded strangely fast

Astronomers have spotted an astonishingly bright explosion that doesn't look like any supernova seen before. An object called AT2022aedm became billions of times as bright as the sun, then faded away fast. It has been named a "luminous fast cooler" (*The Astrophysical Journal Letters*, doi.org/kshq).

The athletes' shirt numbers illusion

We may perceive sports players to be slimmer if they are wearing a lower number on their shirt. People shown cartoon images of American football players viewed them as thinner when they had lower numbers on their shirt than they were when wearing higher ones (*PLOS One*, doi.org/kshs).

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The columnist
Chanda Prescod-Weinstein on physics and *Emmerdale* p22

Aperture
Fascinating fungi from the Ecuadorian Andes and the US p24

Letters
Maybe it is time for people to ditch their smartphones p26

Culture
Explore artificial intelligence in four worrying books p28

Culture columnist
Sally Adee enjoys two excellent existential sci-fi novels p30

Comment

Birth of the cyborg fetus

Developing the "sharenting" habit prenatally, like I did, may affect a child's future on multiple levels, says psychologist **Elaine Kasket**

MY DAUGHTER, now a young teenager, wasn't responsible for the start of her digital footprint. I created that myself, when I posted her 12-week ultrasound on Facebook.

This decision was unthinking, nudged into being through the ambient pressures of social proof. In the US, for example, over a third of expectant parents were posting sonogram images that year, so my digital environment sent the message that sharing about a child from the first scan was acceptable.

Since then, publishing prenatal identity markers has become yet more normalised and common, including biological sex, "gender reveal" videos, the name of the eventual baby, due dates and data from pregnancy-tracking apps.



MICHELLE D'URBANO

When today's expectant parents post a sonogram image – mine featured the hospital's name as well as my name and date of birth – the surveillance-capitalism system is alerted to the imminent arrival of a new person. Text and metadata from ultrasound posts provide additional context for a new profile: the one that a social media platform immediately starts privately compiling about the future consumer.

This is unsettling, but it is the lesser of my worries. While our attention economy may hunger after children's data to supply the burgeoning behavioural futures market, I am more concerned with social and psychological futures. When my social circle showered me with positive reinforcement for my ultrasound post, the trajectory of my digital-age parenting style was set. It was the birth of a habit – a consequential one for my child's psychological development.

With my post, I launched a "datafied baby", whom I would continue to digitally monitor for years. I didn't have the high-priced babyveillance tech of today, but social media was her baby book. With her knowledge and increasingly begrudging consent, I still use phone location tracking to monitor her as she travels alone, grasping towards independence. Almost all teenagers desire freedom, but there is an additional reason she may so crave hers.

A sonogram share discloses information about someone who has no input or agency in the decision. And what could be a one-off instance of taking a free hand with someone else's information is more likely to harden into an established practice. For the decade that followed my prenatal post, I cultivated and curated my child's digital persona in my preferred image. Sometimes, she engaged in protest behaviours that indicated her discomfort, most of which I ignored.

When an expectant parent shares images, information and other identity markers online before birth, they create a cyborg fetus with a social life of its own. The parent's online community nudges them to offer up more. Understandable, then, that it is hard to reel in "sharenting" once your baby is born – and the more parent-authored sharing there is, the more difficult it may eventually be for the child to assert their own identity.

Persistent parental sharenting, especially when a child is resistant, can convey to children that they have no power or right to set their own boundaries. At an early stage, they may realise their experiences are fodder fuelling someone else's social capital. Strangers know all about their lives, may expect them to conform to an image curated by the parent and may seem disappointed if they don't fit with this. Sharented children have a celebrity's understanding of parasocial relationships: people think they know you, but you don't know them.

My own child absorbed these unfortunate lessons well. When her protest behaviours diminished, I now realise, it wasn't because she was content. It was because she was resigned: she had developed what psychologists call learned helplessness. And it all began with a sonogram on social media. ▮



Elaine Kasket is a psychologist and author of *Reboot: Reclaiming your life in a tech-obsessed world*

Field notes from space-time

The physics of a soap opera

Timescales in the British TV show *Emmerdale* make no sense, but maybe this helps to normalise the concept of time dilation, says **Chanda Prescod-Weinstein**



Chanda Prescod-Weinstein is an associate professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her research in theoretical physics focuses on cosmology, neutron stars and particles beyond the standard model

Chanda's week

What I'm reading
Robert Samuels and Toluse Olorunnipa's Pulitzer prize-winning book His Name Is George Floyd: One man's life and the struggle for racial justice.

What I'm watching
In addition to Emmerdale, *I enjoy* Coronation Street *from time to time.*

What I'm working on
I've been thinking deeply about how we define the concept of space-time.

This column appears monthly. Up next week: Graham Lawton

I AM not sure I am supposed to confess to this in public, but I am an avid watcher of the British soap opera *Emmerdale*. It is available to me in the US via a streaming service, and I look forward to watching each day's episode, especially on Thursdays when we get a longer one. The writers are so good at keeping the drama high, and no one actually gets hurt, unlike on reality TV.

Part of how they achieve this high drama is by using timescales that make no sense. For example, a man can cheat on his wife and have a baby with another woman, profess his love for his wife and then the next day be deeply in love with the mistress and totally over the wife, and it looks like maybe only 24 hours or so have passed. Meanwhile, days have gone by in other characters' lives.

Which is to say that, in the *Emmerdale* universe, time is relative. Given that soap operas tend to run on what we might colloquially call "sketchy" notions of the flow of time, maybe avid soap viewers are well-primed to understand fundamental concepts inherent to special relativity and general relativity.

The way time is distorted between different storylines reminds me of the difference between the flow of time near a black hole and far away from it. People who have seen the film *Interstellar* will be familiar with this. At one point in that film, astronauts travel to the surface of a planet where there is strong gravity, in effect because it is near a black hole. When they return to their ship, what felt like an hour to them has been years for their colleague who stayed on the ship.

This is an extreme example of time dilation, in which time appears to flow differently for people experiencing acceleration differently, for example in gravitational fields with differing strengths. This is a real physical phenomenon and not a figment of director Christopher Nolan's imagination.

It even happens here on Earth: clocks at high altitudes will measure time slightly differently to those at sea level. At sea level, the clocks will go slower because they are experiencing stronger gravity than those in the mountains. This is something that has been tested. In 2018, a German team compared the ticking of time on a clock they placed in the French Alps with the ticking of time on a clock in Turin, Italy. Their measurements confirmed that gravitational time dilation did occur, and it was consistent with what the equations predict.

> "Maybe soap viewers are well-primed to understand concepts inherent to special relativity and general relativity"

The experiments work out this way because, unlike old notions where space and time are both absolute, the only phenomenon that is absolute about our reality is a combined space-time. Separate measurements of space and time may vary depending on who is making the measurement and how they are moving, but differences between events in a combined sense of space-time are absolute. That is wild, you might find yourself thinking. But if you spend regular time in the unified *Emmerdale* space-time, maybe you are used to it!

Of course, there are limits to this analogy. In *Emmerdale*, in principle all the storylines are running on the same timeline and there are no extraordinary landscape changes that would produce time dilation in the show. In practice, I think what is actually happening is that they have a carefully choreographed schedule of who appears on camera when, and for how long. It is an impressive feat that leads to stories being told to the viewer in a specific order that respects the workload and schedules of the actors and production team.

I have plenty of respect for the work people put into the series. Nonetheless, it leads to outcomes that can feel a bit silly – a bit soapy, if you will. A man has time to win back the affections of his estranged wife, be diagnosed with an aneurysm, be accused of theft and die – all while his infant doesn't grow at all. It isn't like real life! But maybe it is actually useful for audiences, because it normalises time flowing differently in varied settings – in divergent frames of reference, as we might say in physics.

This has me wondering about the repeated suggestions in science writing for the general public that it isn't possible for people to have any intuition for relativity until they have spent a lot of time with it. I tend to be sceptical about universalist claims about intuition. Readers of my book, *The Disordered Cosmos*, know I think intuition can be social. For example, non-binary people might have an easier time understanding wave-particle duality in quantum mechanics than people who feel comfortably ensconced in the gender binary.

Intuition isn't a substitute for working out the maths if you are aiming for a deeply technical understanding, but we often rely on notions of it to help people get a sense of what the maths is telling us. ▮



SJO/ISTOCK

ADVERTORIAL

All the right mooves: Keeping track of dairy cows with leading-edge sensor technology

The humble dairy cow might seem an unlikely candidate to benefit from the latest in tracking and sensing technology. However, Edward Codling and the team at the University of Essex believe that deploying state-of-the-art sensors and data analytics can reshape traditional farming practices.

Since 2012, Edward and his wider team of collaborators have been monitoring the movement and activity of dairy cows using Fitbit-style sensors, originally designed to track the movements of older people in care homes. Fitting each cow in a herd with a sensor has allowed the team to use movement and behavioural data in an automated way to identify cows with health issues.

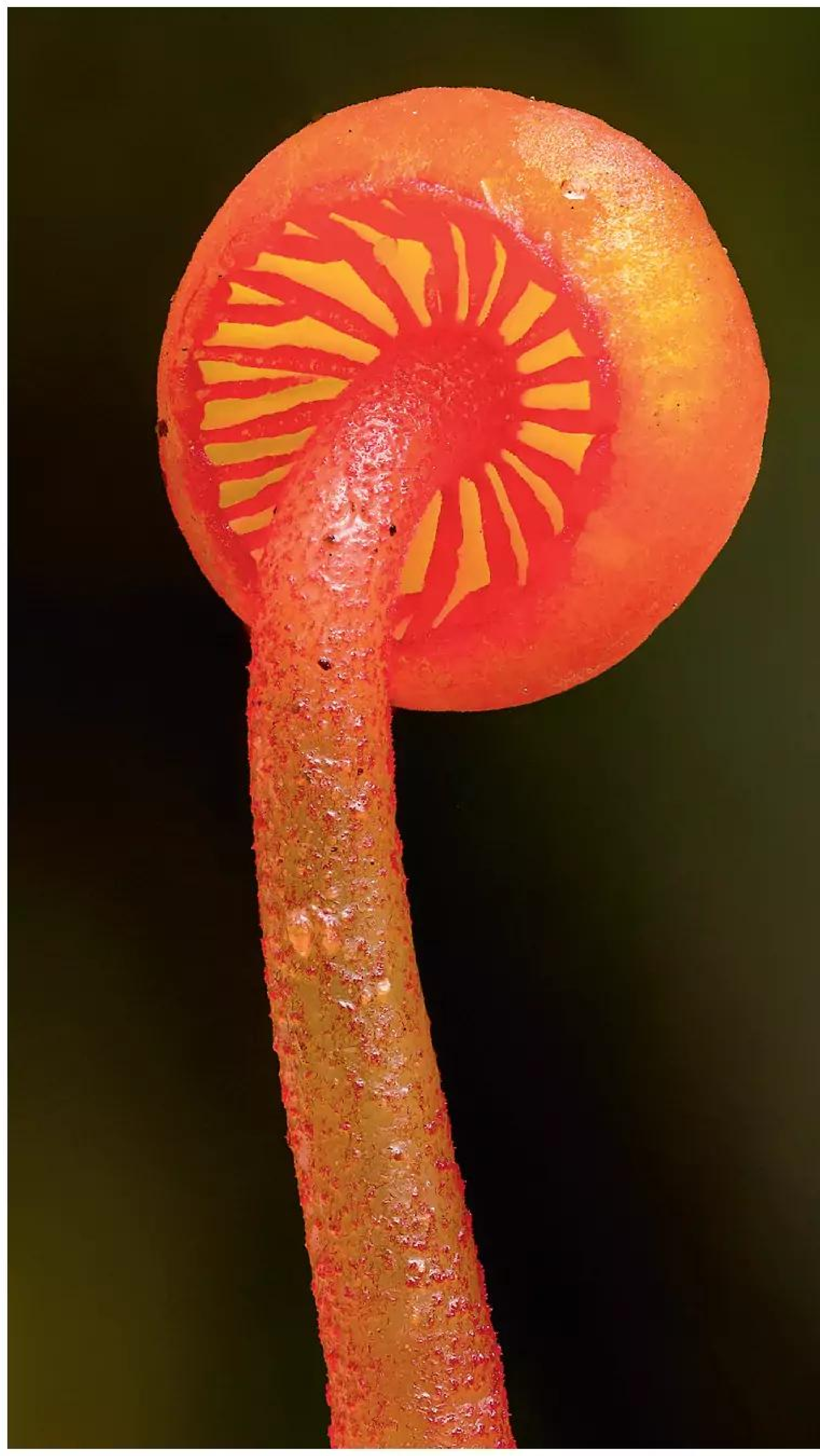
"We have undertaken a number of studies looking at lame cows" Edward says. "Our original hypothesis was that they would move around less, but they didn't, and in fact they moved around the same, but crucially their patterns of behaviour were different. There's lots of possible explanations, but it was quite clear in the data that there was a difference. For example, from the positional and activity data we were able to show that lame cows explored a smaller area within the barn and were more likely to revisit the same areas when compared to healthy cows."

As for what's next, a follow-on project has just started that will explore how environmental sensors can be used alongside animal sensors to determine how individual cows respond to changes in indoor microclimates in hot temperatures. Edward believes that the next stage is to tie together research using these different sensors into a package that's simple for farmers to deploy. "The use of automated sensor monitoring systems will come together in the future in an integrated way so that we're directly able to solve the management problems that farmers may have." Edward adds. **Find out more at: newscientist.com/future-of-agriculture**

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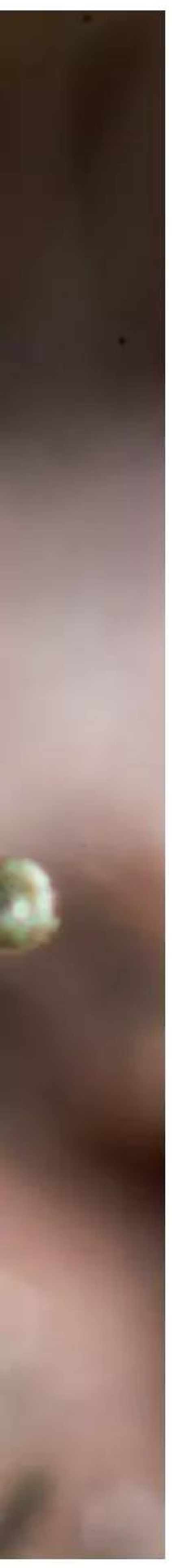
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Fabulous fungi

Danny Newman and Roo Vandegrift

OVER the course of more than a decade, mycologists Danny Newman and Roo Vandegrift went on many expeditions to a virtually unexplored part of Ecuador.

The Los Cedros reserve in the Ecuadorian Andes is a cloud forest, so its main source of precipitation is low-level clouds. Between 2008 and 2019, the pair scouted out as many fungi species as they could in this 52-square-kilometre area. An astonishing 727 were identified. Some of the specimens from Los Cedros are shown here, including one thought to be from the *Mycena* genus (top centre) and a *Favolaschia* (top right), with its distinctive honeycomb-like pores.

"We started studying the fungi there because it's both incredibly understudied and incredibly threatened," says Vandegrift, with mining, tree felling for lumber and clearance for agriculture posing the main threats. The expeditions' findings protected Los Cedros from mining concessions in a landmark ruling in 2021 – opening the eyes of the Ecuadorian court system to the reserve's importance as a biodiversity reservoir.

It is a lesson that can be applied to so many more of the world's habitats, says Vandegrift. "Not every forest, protected or not, gets that kind of attention, but if they did, I guarantee you would find incredible life," he says.

This diversity is highlighted in further specimens Newman collected elsewhere. At top left is a rhododendron blight, a fungal pathogen that infects azaleas and rhododendrons, found in California's Mendocino county, with a close-up of its reproductive structures at bottom left. At bottom right is a fly agaric from Estacada in Oregon.

Gege Li

Editor's pick

Maybe it is time to ditch the smartphone

26 August, p 32

From Richard Hind, Chapel Haddlesey, North Yorkshire, UK

When people ask me (usually in a shocked tone) why I don't carry a smartphone, I answer, half-joking, "because I teach cybersecurity". Amanda Ruggeri's excellent piece on data harvesting is a stark reminder of how this technology is being abused in the name of profit, which makes me feel a little less like a member of the tinfoil hat brigade.

Many people think that "you can't do anything these days without a smartphone". This is a myth. Internet access may be required for a lot of things, but you can get that from a secured personal computer. Basic mobile phones are still available for on-the-go communication.

I find it ironic that people sharing conspiracy theories about tracking chips in vaccines probably did so on a device monitoring their existence in detail. Why aren't those covered by the General Data Protection Rules (GDPR) shouting about violations from the rooftops? Makes you wonder who first circulated those ideas. Please hand me the tinfoil…

From Emma Martins, data protection commissioner, Bailiwick of Guernsey, Channel Islands

We have all contributed to, and been a witness of, the birth of a now deeply entrenched business model that makes its profits from the creation, use and exploitation of our personal data.

To deal with this we need governments to legislate, laws to be enforced, the media to explore, academics to research and civil society to engage. Alone, these influences have limited impact, but together they can lead to sustainable change. This matters in ever more profound ways to all of us, impacting freedoms, rights, democracies and the environment. We all need to care more and do more, individually and collectively.

Let's leave species names as they are

26 August, p 22

From Jon Hinwood, Melbourne, Australia

We shouldn't mess with species names for the sake of 2023 ideas of virtue. As a coastal engineer, I was "house trained" by an ecologist friend and collaborator and learned a heap of names for coastal marsh plants and their ecology. Then some international body changed them all, reducing my ability to interact with botanists and other scientists involved in coastal protection.

Such change also impedes the use of historical data by younger scientists trained in the new nomenclature.

From Geoff Sawers, Reading, UK

Regarding the fate of the genus name *Brontosaurus*. The specimen described as *Brontosaurus excelsus* in the 1870s was later reclassified as *Apatosaurus*, to many people's disappointment. But, in 2015, *Brontosaurus* was reclaimed as a genus by some researchers.

Climate change: so many wasted decades

19 August, various pages

From William Hughes-Games, Waipara, New Zealand

Your climate special gives us some hope that we are on the way to decarbonisation, but also leaves an impression that the situation is going to get worse before it gets better. You have to ask yourself why politicians haven't done more. For instance, a couple of decades ago, they could have ended financial incentives to fossil fuel companies and invested this money into renewable energy. We would now be well past peak carbon output and be watching carbon in the air begin to decline.

The other reason why JFK was a television winner

19 August, p 34

From Ben Haller, Ithaca, New York, US

I enjoyed your look at "the hidden powers of gesture". However, regarding the puzzle posed at the beginning – that people who listened to a debate between the US presidential nominees Richard Nixon and John F. Kennedy felt Nixon won it, whereas those who watched felt Kennedy won – there may be an explanation other than the power of gestures: Kennedy was far better-looking.

We need to rethink modern wildfire strategies

26 August, p 9

From Sam Edge, Ringwood, Hampshire, UK

The story on the impact of ancient wildfires was interesting. When it comes to the threat today, most of what we do aims to stop them happening. This preserves fuel for when a wildfire does get going, making it potentially worse. We must think more strategically.

Perhaps permanent settlements shouldn't be built so close to risky areas and facilities like cabins and adventure parks be mobile, to move when needed. Or maybe owners must accept their possible destruction in an "allowed burn".

Why ocean heat may not be a good energy source

Letters, 26 August

From Paul Whiteley, Bittaford, Devon, UK

Glenda Dixon asks why we can't use warming oceans as a power source. Inevitable waste heat is the problem. Back in the 70s, a system used the warmth of surface water to vaporise a refrigerant and drive an electricity-generating turbine. The gas was then pumped to the cold depths to liquidise. The result is that heat is transferred from the surface to the depths, warming places not normally exposed to varying temperatures, possibly destroying ecosystems.

Please leave the spiderlings alone

19 August, p 18

From Colin Parrish, Doncaster, UK

So spiderlings kept in starvation eat siblings faster than those that are fed. No surprise! What is the purpose of such predictable research? It seems unnecessary and, surely, unethical.

On the dilemma of crops that use a lot of water

26 August, p 36

From Averell Kingston, Sutton under Brailes, Warwickshire, UK

Graham Lawton mentions foods that use most water. Vanilla beans are at the top of the list. A lot are grown in Madagascar, a place where many people live in poverty. This raises a dilemma: should I be supporting their livelihoods or reducing my water consumption?

From Eric Carpenter, Reston, Virginia, US

You stress the thirstiness of coffee, chocolate, tea and vanilla plants, but they are grown in rainforests or in countries with monsoons providing water from rain rather than irrigation. Growing thirsty plants such as almond trees in deserts is bizarre, but taking advantage of abundant rainfall seems like a good idea.

For the record

Felicity Callard at the University of Glasgow, UK, is lead investigator of the rest test (2 September, p 32).

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Looking for your next adventure?



Total Solar Eclipse 2024: Houston to San Antonio, USA

3 April 2024 | 8 days

One of nature's most magnificent events will take place across north and central America on 8 April 2024 and we have chosen Texas as the perfect spot to witness this total eclipse. Renowned astronomer Dr John Mason will lead the eclipse experience at an exclusive viewing location on a secluded ranch as well as giving evening seminars on his eclipse-chasing adventures. There will also be talks from *New Scientist* features editor and astronomer Abigail Beall.

You will also visit several astronomical and geologically interesting sites along the way as you travel through Houston, Austin and San Antonio, including the NASA Space Centre Houston, two observatories, two state parks and the Texas Natural Science Centre.



Dinosaur hunting in the Gobi desert: Mongolia

27 August 2024 | 15 days

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AI's hold on the world

How powerful is artificial intelligence? Where has it sprung from? And what can it really do? Find out in four disquieting books, says **Simon Ings**



A surveillance state is one of the extreme futures that may face us

SEAN GLADWELL/GETTY IMAGES

Books

The Coming Wave
Mustafa Suleyman (with Michael Bhaskar)
Bodley Head

The Handover
David Runciman
Profile Books

The Age of Prediction
Igor Tulchinsky and Christopher E. Mason
MIT Press

Deterrence Under Uncertainty
Edward Geist
Oxford University Press

A SORCERER'S apprentice decides to use magic to help clean his master's castle. The broom he enchants works well, dousing the floors with pails full of water. When the work is finished, the apprentice tries to stop the broom. He can't, so he tries to smash it. The broom splits and regrows, working twice as hard as before, four times as hard, eight times as hard… until the rooms are awash and the apprentice all but drowns.

This is the basis of a poem by Johann Wolfgang von Goethe in 1797. I wonder if it sprang to mind as Mustafa Suleyman wrote *The Coming Wave*? Or perhaps the shade of J. Robert Oppenheimer, father of the atomic bomb, darkened Suleyman's view of artificial intelligence and of his own role in its rise as co-founder of AI leader DeepMind and now as CEO of Inflection AI.

Having launched AI systems, Suleyman and his peers rightly tremble. At one point, he compares AI to an evolutionary burst like the Cambrian explosion 500 million years ago, the biggest ever eruption of speciation.

The Coming Wave is mostly about the destabilising effects of new technologies, how they create a wildly asymmetric world where, say, a single quantum computer might render the world's encryption infrastructure redundant, or one keystroke might repurpose an AI mapping drugs to hunt for toxins.

Extreme futures beckon: there is subjection under a surveillance state, or radical community self-governance in a world where, says Suleyman, "an array of assistants… when asked to create a school, a hospital, or an army, can make it happen in a realistic timeframe".

The predatory city states in this latter, neo-Renaissance future can seem attractive. Suleyman isn't so sure. "Renaissance would be great," he writes; "unceasing war with tomorrow's military technology, not so much."

"Say individual free will survives governance by all-seeing machines. It doesn't follow that human societies will"

A third possibility is infocalypse, where the information ecosystem that grounds knowledge, trust and social cohesion collapses (we will come back to this). But we need to focus on today, says Suleyman. He complains about meetings where he tried to raise questions about synthetic media and misinformation, or privacy, only to be asked about the singularity (a hypothetical time when advanced AI makes our civilisation obsolete) or machine consciousness.

Historian David Runciman makes an analogous point in *The Handover: How we gave control of our lives to corporations, states and AIs*, an impressive account of the limited liability company and the modern nation state. The rise of these "artificial agents" at the end of the 18th century was, Runciman argues, "the first Singularity", when we tied individual fates to two distinct but compatible autonomous systems.

These "have a lot more in common with robots than we might think", he writes. Our political systems are artificial and autonomous: fail to grasp this and we won't understand what happens or what to do as they acquire new intelligences.

Long-lived, sustainable states with a healthy balance between political power and civil society won't keel over under helpful AI, Runciman predicts. But as they embrace it, they will grow more automated and disconnected from human affairs. How will we ever escape this machine utopia?

Human freedom may still be a force to reckon with, say Igor Tulchinsky and Christopher E. Mason in *The Age of Prediction: Algorithms, AI, and the shifting shadows of risk*. They explore why the more predictable world ushered in by AI may not be safer. Humans evolved to take risks, and weird incentives emerge when predictability seems to increase and risk seems to decline.

Tulchinsky, who analyses data flows in financial markets, and Mason, a geneticist who maps dynamics across human and microbial genomes, make odd

bedfellows. Mason welcomes any advance that makes medicine more reliable; Tulchinsky fears perfect prediction would render humans as docile and demoralised as cattle. The authors' spirited dialogue illuminates their detailed survey of what predictive tech can do, from warfare to politics.

Let's say they are right and individual free will survives governance by all-seeing machines. It doesn't follow that human societies would survive their attentions. This is the unexpected sting in the tail in Edward Geist's *Deterrence Under Uncertainty: Artificial intelligence and nuclear warfare*, a gripping analysis of AI's role in such conflict.

Geist, steeped in the history and craft of deception as a specialist in defence policy and security, thinks even the smartest agent can be made self-destructively stupid by subterfuge. Fakery is so cheap and effective that Geist envisions a future where AI-driven "fog-of-war machines" create a world that favours neither side, but backs "those who seek to confound".

In Geist's hands, Suleyman's "infocalypse" is a far cleaner and cheaper weapon than any bomb. Imagine future wars using mind games. In such a shifting world, people could be persuaded their adversary doesn't want to hurt them. Rather than living in fear, they would see the adversary's values are, and always have been, better than theirs. Depending on your politics and sensitivity to disinformation, you may feel this future is already upon us.

And, says Geist, at his most Machiavellian, "would it not be much more preferable for one's adversaries to decide one had been right all along, and welcome one's triumph?" ▮

Simon Ings is a writer based in London

A real trip

Personal experience of psychedelics is a key to learning about them, finds **Thomas Lewton**

Book
Ten Trips
Andy Mitchell
Bodley Head

DESCRIBING your psychedelic trip to other people is notoriously dull. Poet or not, there will always be a gap between the raw experience of LSD or magic mushrooms, and a second-hand metaphor.

So it was with hesitation that I picked up neuropsychologist Andy Mitchell's book *Ten Trips: The new reality of psychedelics*, detailing his personal journey. In a few months, Mitchell spends several hundred hours taking 10 drugs as "a douchey forty-nine-year-old psychedelic virgin".

But his honesty about his recent personal traumas, and about the risks of psychedelics running alongside the highs and the revelations, make him a thoughtful guide.

US citizens appear to be warming to psychedelics, and therapies using them are close to being legalised or decriminalised in more states. Meanwhile, investors are cashing in. And even though many psychedelics originated with Indigenous peoples, they rarely benefit and are often excluded.


GIULIO PALETTA/EDUCATION IMAGES/UNIVERSAL IMAGES/GETTY

Preparing the psychedelic ayahuasca – but will Indigenous groups benefit?

Then there is the touchy issue that some psychedelic therapies used to treat depression, post-traumatic stress disorder and addiction haven't proven as impressive in larger clinical trials, not to mention the small but significant (and often underreported) cases of bad trips. If and how to meld psychedelic therapy with Western society is still up for grabs.

As a sceptic, Mitchell takes this in his stride. Psychedelic science, he writes, can veer towards "evangelical optimism". But he hopes that embracing the nuances of psychedelic trips will help us "think better about these drugs, and maybe with them too".

Mitchell starts in a London kitchen with a "shallow" ketamine trip, and ends taking wachuma with a shaman in the Colombian Amazon. On the way, magic mushrooms bring him to tears at the sight of a trash can, while ayahuasca sees him tormented by eels.

This isn't *Fear and Loathing in Las Vegas*, but it doesn't need to be. Some of Mitchell's clearest insights occur when his reports are interwoven with armchair philosophy and new theories about how psychedelics work. Science can only have one view of psychedelics, but, as virtual-reality pioneer Jaron Lanier tells Mitchell, objective science entails "a collapse of experience itself". *Ten Trips* is a powerful reminder that psychedelics can't be made sense of entirely within a framework of chemical interactions in the brain. We need to view them as something potent, to be respected. ▮

New Scientist *recommends*



Karmela Padavic-Callaghan
Reporter
New York

Flying to a conference recently, I had time to catch up on my podcasts, including episodes of the cheeky yet informative **You're Wrong About**, where hosts and



guests reanalyse a misunderstood or misremembered event. The episode featuring science journalist Lulu Miller, in which she probes the science of same-sex relationships among animals and the fraught history of that science, made a strong impression on me.

I am currently reading **Monolithic Undertow**, an exploration of drone music by Harry Sword. As a longtime fan of loud and grating genres, I was expecting to learn more about some of my favourite bands, but Sword approaches the idea more expansively.

He starts with ambient noises in the womb, the background hum of the universe and prehistoric bone instruments, taking generous detours into acoustic science and neuroscience before mentioning heavy metal. This delighted me as a science-minded reader.

The sci-fi column

The big question

The protagonists of two excellent new sci-fi novels are trying to find their way out of existential misery. And at their hearts, both books are setting out to explore what on earth we are doing here, finds **Sally Adee**



Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee

Books

The Circumference of the World
Lavie Tidhar
Tachyon Publications

Starter Villain
John Scalzi
Macmillan
(21 September, UK; 19 September, US)



KUBAN_GIRL/SHUTTERSTOCK

Managerial cats provide a lighter moment in John Scalzi's *Starter Villain*

DANIEL CHASE, a dealer of rare books, is sitting at his aunt's deathbed. "She sighed in the way distant members of my family, who never otherwise took much interest... always sighed when my name came up in conversation: 'I feel that you'll need all the help you can get in life.' "

Charlie Fitzer has also been written off as a struggling middle-school teacher with a failed marriage. But both lives are kicked into gear by unexpected gifts from dying relatives who turn out to be more surprising in death than they ever were in life.

This pair from two excellent new books take on the biggest question: what exactly are we doing here? It is a question science fiction is uniquely placed to explore. Both Daniel, in Lavie Tidhar's *The Circumference of the World*, and Charlie, in John Scalzi's *Starter Villain*, are stuck in the same existential misery. Their very different stories converge on the same truth.

As is typical of Scalzi, his entire premise is larded with absurdist humour. Charlie has drifted aimlessly through life until his distant uncle dies and leaves him the volcanic island lair in which he engaged in supervillainy. But not of the traditional kind. "A stupid villain threatens, Charlie," a new mentor advises. "A smarter villain offers a service." Amid classic Scalzi set pieces like a class of managerial cats or dolphins on strike – and moments when you will laugh so loudly you will wish you weren't reading in public – Charlie discovers meaning, as he transitions from someone who doesn't know what to do with his life to being instructed in the finer points of supervillainy-as-service.

> **"These books may be fun, short and tightly plotted, but their philosophical power is typical of longer texts"**

Tidhar's melancholy, beautiful and yet improbably light-touch narrative, meanwhile, is structured like a nesting doll. In it, a mathematician chases proof of the anthropic principle (astronomer Robert Dicke's 1957 conjecture that the universe evolved to be hospitable to intelligent observers so we could evolve to be those intelligent observers). After he finds a manuscript that could help crack the code, he disappears, and his wife, Delia, hires Daniel to find him. Then cosmic forces intervene and things get weird (maybe don't start this book on a Sunday night).

Scalzi is concerned with what we do with our one life, drawing a straight line between the hot pursuit of leaving your mark on the world and the emergence of supervillain traits. Tidhar is more concerned with how we shy away from wondering why we are here. Walls, artificial lighting and mindless TV all conspire to hide the universe so you could pretend "you were not a passenger on a planetary starship travelling through the visible universe at a speed of forty three thousand miles per hour around the galactic centre of the Milky Way", Delia muses. "We don't know why we're here."

These books may be fun, short and tightly plotted, but their philosophical power is more typical of much longer texts. We all struggle with the mystery of existence and what we are meant to do with these lives. In the absence of unexpected legacies from benevolent relatives, the rest of us are left to navigate the existential shoals alone. Science fiction's star has risen, both books seem to suggest, because the guidance encoded in its stories can fill that void, helping us chart a path in the unfathomable order.

In the end, we need all the help we can get. ▮

Sally also recommends...

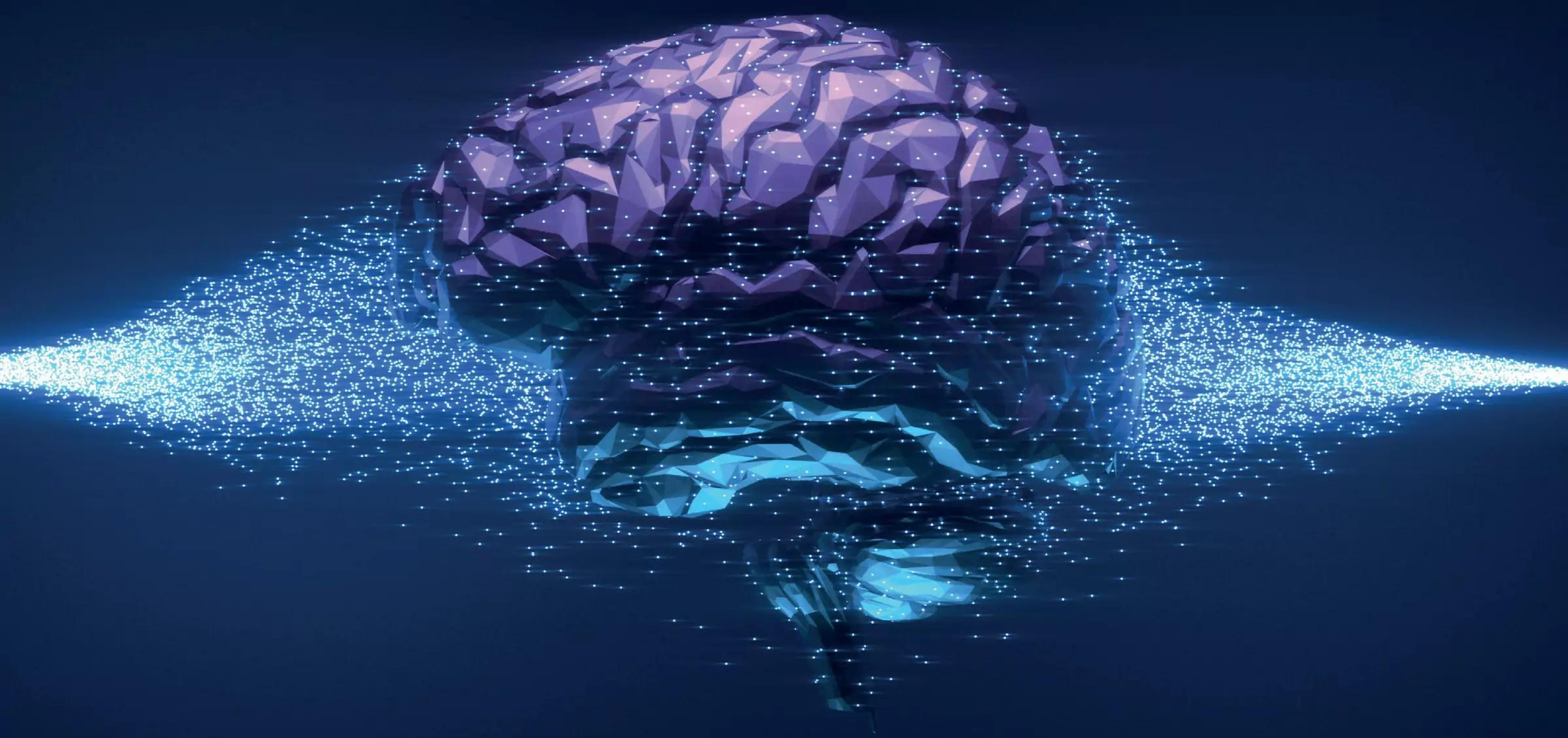
Book

Counterweight
Djuna
Pantheon

Anonymous sci-fi novelist Djuna has created a world in which AI-mediated neurotechnology lets your personality live in someone else's head. There are also space elevators, murders and Succession*-style corporate family scandals.*

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The truth about CBD

Health claims about cannabidiol are rapidly outpacing the evidence. **Corryn Wetzel** looks at how to separate hope from hype

HAND lotion, dog treats, deodorant. Pillows. Beard oil. Sports bras. The range of CBD products now available is as broad as the health claims these products are marketed with. Items containing CBD, or cannabidiol – the non-intoxicating compound derived from cannabis plants – are touted to stave off wrinkles, improve sleep, reduce anxiety, ease menstrual cramps, prevent hair loss and more.

Celebrities are in on the action. Jennifer Aniston champions CBD for reducing pain and stress. Mike Tyson has a line of CBD dog chews. And business is booming: around 1 in 7 adults in the US say they use products containing CBD, while in the UK a quarter of adults say they would try it and 1 in 10 people under 24 already have, according to polls. In 2020, people in the US spent $4.6 billion on such products. Next year, that could balloon to more than $20 billion. In the UK, the CBD market was valued at £690 million in 2021.

Early evidence hints at many potential medical applications, for issues ranging from arthritis to addiction. But as the skyrocketing popularity of CBD leaves researchers and regulators scrabbling to catch up, we are left with an overwhelming number of products on the market, some of which may work, others whose claims are baseless.

Thankfully, we are starting to get some answers that can help us navigate through the confusion, enabling us to figure out what CBD really does, how it can benefit our health and what products are just a waste of money.

CBD is one of more than 130 compounds found in the cannabis plant known as cannabinoids. It is perhaps the second best known after THC, or tetrahydrocannabinol. THC creates the marijuana "high"; CBD won't get you stoned. "You couldn't get high with it if you tried," says Peter Grinspoon, an internist at Massachusetts General Hospital.

Researchers have known about CBD since the compound was first isolated from a cannabis plant in the 1940s, but, until recently, it has been far less closely studied than intoxicating THC. However, a handful of policy changes in the past decade have made it easier to produce and sell CBD in the US, UK and elsewhere – and set the stage for the current proliferation of products that contain it (see "The CBD explosion", page 35).

Regulators and researchers are struggling to keep up. The US Food and Drug Administration (FDA) acknowledged earlier this year that it isn't currently equipped to successfully regulate the compound. "The claims of benefits for CBD have soared so far above the evidence base," says Grinspoon, who is the author of the recent book *Seeing Through the Smoke: A cannabis specialist untangles the truth about marijuana*.

> "Effective CBD therapies have huge appeal: they are cheap, easy to get and safe at high doses"

To date, the FDA has approved just one CBD drug. In 2018, the agency authorised the use of Epidiolex – also available in the UK, other parts of Europe and several other countries – for treating seizures caused by Lennox-Gastaut syndrome and Dravet syndrome, severe forms of childhood epilepsy. In Canada, Australia, Europe and the UK, the oral spray Sativex has also been approved to ease symptoms of multiple sclerosis, including muscle spasms and nerve pain. It hasn't yet been authorised by the FDA, however, after disappointing results in a late-stage clinical trial in 2022.

Although dozens of clinical trials are under way in the US alone – investigating CBD to manage everything from insomnia to symptoms of Alzheimer's disease – most of that research is at an early stage.

The appeal of effective CBD-based therapies is huge. The compound is comparatively cheap and easy to come by, has been shown to be safe even at high doses and isn't habit-forming. The pharmaceutical industry is certainly paying attention. A 2021 analysis by cannabis market research firm Brightfield Group noted that, even with just one CBD-based drug available in the US, CBD pharmaceutical sales were worth $470 million in 2020. By 2026, with fair winds and further FDA approvals, the firm expects that to more than quadruple to over $2 billion.

As the opioid overdose crisis continues in the US, many are hopeful that any new CBD-based drugs will include urgently needed options for pain management. Pain treatment isn't only a leading area of CBD research, but it is the reason most people give for using the compound.

There are promising signs. Beyond its potential to treat painful symptoms of multiple sclerosis, it can also help with other forms of chronic pain, according to a recent review of a dozen high-quality studies. Survey results from 2021 echo this: of people who attended special clinics for treating chronic pain, two-thirds said they had tried CBD. Of those, the majority said it reduced their pain and enabled them to cut back on medications, including opioids.

Unfortunately, the evidence around pain ›



MURUGIAH

relief is still far from conclusive. For instance, in a 2021 study, when volunteers submerged their hands in icy water, CBD provided no benefit over placebo in increasing pain tolerance and even increased pain on some measures. There are also mixed results when it comes to studies looking at the use of CBD for treating pain associated with arthritis, and while CBD may help ease pain linked to fibromyalgia, it appears to provide the most relief when THC is also present.

With a compound that is now so popular – and has the added bonus of a wellness halo thanks to its natural origins and bold claims about its benefits – expectations may also make a big difference. It turns out believing that CBD reduces anxiety may be powerful in its own right. In a study where people were given CBD-free hemp seed oil but told it contained the compound, participants' heart rates lowered and they reported a drop in stress levels – but only if they believed CBD had the power to produce these effects.



PANTHER MEDIA GMBH/ALAMY

The market for products that contain CBD is booming

And relax...

There does seem to be more than expectation at work when it comes to using CBD to treat anxiety, however.

In 24 people with generalised social anxiety disorder who had never tried CBD, a single 600-milligram dose helped reduce anxiety before a public speaking task, for instance. In a larger study published this year, people given a 300mg dose each day for two weeks reported a significant reduction in worries and anxiety compared with those given a placebo. In a 2019 study, people who struggled with anxiety and related sleep disruption were given 25mg of CBD daily. After a month, 79 per cent reported less anxiety and 67 per cent said they had slept better.

Researchers are confident that such work will lead to useful treatments, yet are under no illusions about what limitations there will be. "The future for CBD-based products is incredibly promising, but that doesn't mean it's right for all people for all things," says psychiatrist Staci Gruber at Mclean Hospital in Massachusetts.

Another area of particular interest is in treating substance misuse, including addictions to opioids and cannabis. Last year, a review of the existing research on CBD and opioid withdrawal found evidence that the compound can reduce cravings. In 2019, a study of 42 people with heroin addiction found that ingesting 400mg or 800mg of CBD also markedly reduced physiological measures of stress around these urges, such as increased heart rate and levels of the hormone cortisol.

In a month-long trial of 82 people classified as "severely addicted" to marijuana, some took either a high, medium or low dose of CBD while trying to quit using the drug. Others received a placebo. Those who got the middle dose of CBD – 400 milligrams per day – consumed around half the amount of marijuana as those given the placebo.

Yet for all of these encouraging results, a major challenge in figuring out what conditions CBD might be useful for is that, even for approved treatments, we don't have a clear idea of exactly why it is working.

"CBD is what's called a promiscuous molecule. It interacts with dozens of different receptors," says Grinspoon. We know, for instance, that CBD binds with some nerve cell receptors that also bind with capsaicin, the molecule that makes chillies spicy. Capsaicin affects neurotransmitters that relay pain signals to the brain, which may be how CBD eases chronic pain for some people. CBD also binds to some types of receptor for the neurotransmitter serotonin, which plays a role in regulating mood, and could be a way by which it helps to relieve anxiety.

> "The future for CBD products is promising, but it's not right for all people for all things"

We also know that CBD interacts with receptors in our endocannabinoid system, a complex and ancient signalling network in the body that regulates many key functions, including pain control and immune responses. For instance, clinical trials have shown that CBD can boost the amount of anandamide, an endocannabinoid that produces feelings of delight, perhaps explaining the "bodily high" or deep sense of relaxation many users report.

Yet we are still working to pin down which receptors are involved and to what extent. "We're just beginning to learn what [CBD] does and how it does it," says Grinspoon.

Further complicating matters, even when we start to pin down how the molecule can ease pain or anxiety, it doesn't follow that any CBD products will offer those benefits. The CBD doses that are starting to show therapeutic effects in clinical trials are frequently in the hundreds of milligrams – far more than what is in most off-the-shelf goods.

"Three-hundred milligrams of oral CBD might show some slight signal that it could reduce anxiety, but whether that would also translate to taking 10 milligrams of CBD in your coffee, no one really knows the answer to that yet," says Tory Spindle at Johns Hopkins University in Maryland.

Another big unknown is how much of the stuff you are really ingesting. To begin with, how you consume CBD affects how much you absorb. When it is taken in a food or drink, people absorb around 15 per cent. A CBD patch or under-the-tongue tincture is closer to 30 per cent. With pillows or eye masks, who knows?

Tests of off-the-shelf items show that the amount of CBD on the label may not be accurate anyhow. Last year, a study of 105 topical CBD products available in stores and online in the US found that only around a quarter were correctly labelled. More than

The CBD explosion

In nations with legal CBD, it comes almost exclusively from hemp – a kind of cannabis plant that has scarcely any THC. A US law change in 2018 that made it legal to grow hemp really kicked off CBD's rapid rise in popularity.

Legalising hemp made it easier to add CBD to foods, beauty products and more without much oversight, and the US Food and Drug Administration has yet to make a coherent plan for regulation beyond issuing occasional warning letters to manufacturers making unsubstantiated health claims.

The UK, Canada, Australia and other countries where CBD is legal have more coherent monitoring and authorisation systems in place, but the rising volume of products is making it difficult for regulators to keep up (see main story). CBD is also catching on in other nations that have loosened legal restrictions, such as Belgium, France, Germany and Poland.

Support for cannabis more broadly has surged too, particularly in the US, where it is now legal for either medicinal or recreational use in 38 states.

half the products contained more CBD than advertised, while 18 per cent contained less. A similar 2019 study in the UK tested 29 store-bought CBD goods and found one item, an oil selling for £90, contained no CBD whatsoever.

Inaccurate labelling may result in people taking more CBD than expected, but the risk of deadly consequences is close to zero. People can tolerate doses of up to 1500mg of pure CBD without major issues, though very high doses can cause nausea, diarrhoea, drowsiness or confusion for some people.

There is also the issue that these goods may contain unwanted ingredients. The study of topical CBD products found that more than a third of those tested had small traces of THC, including four that were explicitly labelled as THC-free.

Hidden ingredients

Testing also takes time and money, and studies have shown that some manufacturers skip testing protocols required by consumer protection agencies. The volume of products on the market has made it easier for questionable ones to slip through as well. A 2022 report on 188 North American CBD companies found that 1 in 5 provided no evidence of purity testing. That is a worry: some products tested in the US and UK have been shown to contain surprise contaminants like pesticides, heavy metals and potentially harmful microbes.

For those reasons, Spindle says that people who want to try CBD or are already regular users should buy from licensed retailers. "That would be the only way to ensure there's some degree of quality control." Legitimate products sold in the US and UK will have a certificate of analysis and be tested by a third-party lab, which buyers can ask to see. If you only want CBD, look for the terms "CBD isolate" and avoid "full spectrum" or "broad spectrum", which can include other cannabinoids.

Gruber says you should also talk to your doctor. Just as grapefruit juice can affect how some medications are metabolised by the body, so can CBD. Especially when taken orally, CBD can compete for enzymes involved in drug metabolism in the liver, changing the amount and timing of delivery for some drugs. "If you happen to be on a blood thinner, CBD interacts pretty significantly with some of these anticoagulants," says Gruber.

She and others acknowledge that, even with limited oversight, many people want to try CBD, particularly if they think it might help where other treatments have failed. But studying the products available on store shelves isn't straightforward. In many countries, researchers are barred from testing real-world CBD products for medical purposes, relying instead on CBD samples with origins and purity guaranteed by their government. In the US, for decades the only option was to use CBD from approved hemp grown by a single institution, the University of Mississippi.

"Consumers will go down to a dispensary and have a staggering array of products available to them, but I can't use one drop of any of those products in a clinical trial, because if I do, legally, they're being evaluated as a [medical] drug," says Gruber.

Thanks to a law introduced in the US in 2016, that is starting to change, albeit slowly: other growers are now approved to cultivate marijuana for research and product development. "CBD is more readily accessible, and it's cheaper and easier for us to do research now," says Ryan Vandrey at Johns Hopkins University.

That means, despite the overwhelming unknowns about CBD right now, experts are optimistic we will have a much better understanding of its potential benefits within the next decade, if not sooner. "We're definitely headed in the right direction," says Grinspoon. "We will get the answers that we're looking for." ▮



RICHARD LEVINE/ALAMY

Most clinical trials of CBD are still in early stages



Corryn Wetzel is a reporter at *New Scientist* based in our New York bureau



KLAWE RZECZY

Information wars: The final battle?

Researchers and governments are finally fighting back against the deluge of online disinformation – just as artificial intelligence threatens to supercharge the problem, finds **Graham Lawton**

IN OCTOBER 2021, Phil Howard, an internet researcher at the University of Oxford, was alerted to a preposterous story on social media. It alleged that the covid-19 pandemic was started by a shipment of Maine lobsters that arrived in Wuhan, China, days before the first outbreak. He and his colleagues spent months trying to track down the source and didn't get to the bottom of it – except that it probably originated in China, possibly through the state-owned TV channel CGTN.

"I felt my career had hit a new low," says Howard. "What was so ridiculous was the enormous effort that we needed to expose a ridiculous attempt to manipulate public opinion. I realised that I didn't want to do that work myself, so I decided to try and come up with an initiative that would do something about the problem in a systematic way."

Today, Howard is chair of a new organisation called the International Panel on the Information Environment, one of many initiatives pushing back against the pollution of the information ecosystem. Regulators, too, are finally lacing up their own boots after spending years sitting on their hands.



The stakes couldn't be higher, with the recent rise of generative artificial intelligence and its capacity to produce persuasive disinformation on an industrial scale. Many researchers are saying that the next two years are make or break in the information wars, as deep-pocketed bad actors escalate their disinformation campaigns, while the good guys fight back. Which side prevails will determine how the information environment – and everything it shapes, from people's beliefs about vaccines to the outcomes of elections – will operate for the foreseeable future.

Misinformation and its nefarious cousin disinformation, defined as misleading information that is seeded deliberately, have been around for thousands of years. But the advent of social media was a watershed in the sense that it put the tools of disinformation into the hands of the masses, with seismic consequences.

Research shows that fake news spreads six times as fast as true news, says former Google employee Tristan Harris, who now runs the Center for Humane Technology in San Francisco. "Even though there's a very small number of extreme voices out there, social media takes that 5 per cent of the population and then stretches it out over the whole movie screen of humanity."

Why false information spreads so far and wide is well known. The algorithms that serve up content on platforms such as Facebook, Instagram and X (formerly Twitter) have two overriding goals: to capture and keep people's attention, and to motivate them to share content by rewarding them for doing so. The more provocative the content, the more successful that strategy. "People are getting social rewards for sharing very emotionally provoking information or information that's not the most accurate," says Gizem Ceylan at Yale University. Moreover, the act of sharing becomes habitual. "Over time, you become like a pigeon pecking at a button with the hope of getting food, but you don't realise it," she says.

Ceylan's research demonstrates how the problem manifests. In an experiment, she and two colleagues showed Facebook users true and fake headlines and asked them whether they would share each of them. The heaviest users of the site said they would share 37 per cent of the fake headlines and 43 per cent of the true ones. "They were completely insensitive to the truthfulness of the information," says Ceylan. Most people want an unpolluted information environment, she adds. The trouble is that the reward structure of social media thwarts the will of the people.

There are real world consequences, personified in many people's minds by the attack on the US Capitol building on 6 January 2021, seemingly inspired by conspiracy theory about electoral fraud. Disinformation has also been blamed for other societal phenomena, including political polarisation, climate and election denial, and anti-vaccination sentiment. But the evidence joining the dots is lacking. "What's hard is to know how many people change their minds or change their votes because of something said," says Howard.

Indeed, recent research suggests that social media isn't to blame for political polarisation, though the results are controversial. In early 2020, a team of researchers from Meta approached two social scientists, Talia Stroud at the University of Texas at Austin and Joshua Tucker at New York University, ›

Fighting for facts
Listen to Sander van der Linden discuss how he creates psychological "vaccines" against false information newscientist.com/nslmag

to propose a research project on how its social media platforms Facebook and Instagram influenced users in the period around the US presidential election. Meta offered the researchers unprecedented access to its data and freedom to choose the research questions and study designs. The result was the 2020 Facebook and Instagram Election Study, which published its first results in July this year.

The research showed that Meta's algorithms have a massive influence on the content people see, and that people with different ideologies see very different political content. All of which is unsurprising. It was in addressing the other questions on the agenda – primarily, whether tweaking the algorithms that determine what people see had any effects on their political positions – where it got interesting.

Recall that the election was on 3 November. Between 23 September and 23 December 2020, the academics made three major changes to Meta's algorithms, tested them on three separate groups of around 23,000 consenting users and measured the effects. The first change was to remove posts shared by users' friends, or "reshares". The second was to switch off personalised feeds, which prioritise content the user is expected to engage with more, and instead present content chronologically. The final change was to deprioritise content from politically like-minded sources.


TING SHEN/XINHUA/ALAMY

Meta CEO Mark Zuckerberg prepares to testify to Congress about the role of Facebook in spreading misinformation, among other things, in 2018

Then came the big reveal: none of these changes had any influence on the users' political attitudes or voting intentions. None. "We now know changing the algorithm for even a few months isn't likely to change people's political attitudes," says Stroud.

Lack of clarity

Meta lapped up the results. In a lengthy press release, Nick Clegg, president of global affairs, said that the studies "add to a growing body of research showing there is little evidence that key features of Meta's platforms alone cause harmful 'affective' polarization, or have meaningful effects on key political attitudes, beliefs or behaviors". Academics say this is a rush to judgement. "I think their finding is that there are no short-term noticeable effects," says Howard. "The long-term effects are still a bit of an unknown."

It was a similarly frustrating lack of clarity regarding the impact of social media on political outcomes that partly convinced Howard that a systematic scientific effort was urgently needed to track, understand and counter disinformation. He teamed up with veteran activist Sheldon Himelfarb, who runs a non-profit organisation called PeaceTech Lab in Washington DC. In April 2021, they proposed the foundation of an international body on disinformation modelled on the Intergovernmental Panel on Climate Change. The International Panel on the Information Environment, or IPIE, was formally launched at the US National Academy of Sciences in Washington DC in May.

In its first piece of work, IPIE systematically reviewed hundreds of papers on strategies to tackle disinformation on social media. It found that of multiple plausible ways to do so, only two are proven to work: content labelling, where posts are tagged with fact-checks and disclosures about who paid for them; and corrective information, where somebody with authority debunks disinformation on social media in a separate, unlinked piece of content. "For now, these are the only two solutions we feel confident about," says Howard.

Moderation, where platforms take down content or suspend and block accounts, works somewhat, as does media literacy training for users. But everything else that has been tried – allowing users to report disinformation, inhibiting the sharing of dodgy content, telling users they have consumed misinformation, redirecting users to reliable sources and so on – are as-yet unproven.

The fundamental problem is that none of this can compel the platforms to act, says

What ChatGPT knows about AI disinformation

The rise of chatbots powered by artificial intelligence threatens to supercharge the production of false information (see main story). We asked OpenAI's ChatGPT whether generative AI can produce disinformation. The results were, in their own way, instructive.

"Yes, generative AI can potentially produce disinformation. Generative AI models, like GPT-3, are designed to generate text based on patterns and examples present in the data they were trained on. They do not have an inherent understanding of truth or ethics and are agnostic to the factual accuracy of the information they generate.

"If the training data includes examples of disinformation or misleading information, the AI model may learn to generate similar content when prompted with certain cues. Furthermore, if a user intentionally feeds the model with false or misleading information, it can produce responses that propagate disinformation.

"OpenAI and other responsible AI developers are aware of this risk and encourage ethical use of AI to prevent the spread of disinformation. They may implement moderation systems, provide guidelines to users on ethical AI usage, and try to minimize the likelihood of models generating harmful content. However, it's essential to remember that the potential for generating disinformation exists, and it's the responsibility of users to use AI technology responsibly and consider the consequences of their actions."

Howard. "Experience has shown us that we cannot leave it to the social media platforms or the other tech platforms alone," says Melissa Fleming, the UN's under-secretary-general for global communications. "We do feel like we are in an information war."

That is where governments enter the fray, and they are finally taking action. Leading the charge is the European Union's Digital Services Act. This legislation, which will be applied from 17 February 2024, will compel larger social media platforms to limit the spread of illegal content, be more transparent about their moderation decisions and allow users to challenge them when they believe their content has been unfairly removed or down-rated.

"Most importantly, it obliges [the platforms] to have risk assessments on how the design and functionality of their platforms influences elections, civic discourse and how illegal content is disseminated," says Agne Kaarlep, a former policy officer for digital services and platforms at the European Commission and now head of policy at content-moderation company Tremau.

The Digital Services Act also compels social media companies to be more open with their data. That is potentially a big win for scientists, says Howard. "So many of the effects that we were uncertain about are going to take deep, deep data access [to identify]" he says.



KLAWE RZECZY

"WE CANNOT LEAVE IT TO THE SOCIAL MEDIA PLATFORMS. WE DO FEEL LIKE WE ARE IN AN INFORMATION WAR"

A looming threat

Similar legislation is afoot in the UK, Australia, Brazil and Canada. The UN is also drawing up a code of conduct. But the US is conspicuously absent from the regulatory party. This is largely because of the US Constitution's first amendment of 1791, which says that congress will make no law abridging the freedom of speech.

However, free speech may not be a trump card. A recent study led by Stephan Lewandowsky at the University of Bristol, UK, polled 2564 people in the US on their attitudes towards content moderation. "The overarching finding was that people are OK with content moderation," he says. "They do support the removal of misinformation that is demonstrably causing harm."

Perhaps the biggest problem, however, is that all this is happening in the face of another looming threat: generative AI tools that can produce convincing text, pictures and video in response to human prompts. "When we think about the way in which disinformation is produced and distributed at the moment, generative AI is going to supercharge that," says Stephen King, CEO of the foundation Luminate, which works to address digital threats to democracy. "What we will be looking at in a year's time, two years' time, is going to be of a scale and magnitude which we can't really imagine. The problem is going to get worse before it gets better."

Bad actors may use publicly available generative AI, such as ChatGPT, or even build their own propaganda algorithms trained on disinformation, says Howard (see "What ChatGPT knows about AI disinformation", left). "You can now generate 10,000 different lies and figure out what goes viral," says Frances Haugen, formerly of Facebook, who in 2021 disclosed documents detailing the company's failure to curb misinformation, and is now at Beyond the Screen, a non-governmental organisation that campaigns for greater checks and balances on social media platforms. "We're going to be playing a very, very different game."

Recent research suggests it may be a losing one. "When you train generative AI on human-written propaganda, the algorithm's propaganda is viewed as more persuasive, at least a little bit, because it's more succinct, it's shorter, it's punchier," says Sander van der Linden, a psychologist at the University of Cambridge.

In July, the disinformation-fighting tech company Logically released the results of a chilling experiment with generative AI. Its researchers asked three image-generating AIs – Midjourney, DALL-E 2 and Stable Diffusion – to produce fake images relating to hot-button political issues in the US, India and the UK. Sometimes AI's can refuse to answer such queries because their developers have decided it steps on dicey territory. However, most of their prompts were accepted and some produced extremely plausible disinformation images, including those of electoral fraud in the US, protesters toppling a statue of Isaac Newton in Cambridge, UK, and Muslim women wearing saffron scarves in support of the Hindu nationalist Bharatiya Janata party in Delhi, India.

"Eighty-six per cent of the images that we tried to create did actually bring through some disinformation in really hyper-realistic images," says Beth Lambert at Logically, and a former head of counter disinformation in the UK Department for Culture, Media and Sport. ›

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When humans were producing disinformation there used to be a trade-off between quality and quantity, she says. Not any more.

The speed at which the technology is moving is also creating concern. At the moment, generative AIs can produce text, images or video, but not in combination. The next development will be multimodal versions capable of generating all three at the same time on the same topic, says Stevie Bergman of the ethics research team at AI company Google DeepMind. "Being able to do multiple of these has particular implications for how to limit misinformation or disinformation, and what misinformation or disinformation even looks like," she says. Multi-agent AI, where generative AIs talk to one another to solve problems, is also advancing rapidly, she says, with unknown consequences.

A more distant but plausible possibility is what Sam Stockwell at the Alan Turing Institute in London calls autonomous intelligent agents: generative AIs that can be given a task and that then go away and figure out how to do it without further prompts from a human. "You have the prospect of an AI agent running a disinformation strategy," he says.

Through all the gloom, there are potential upsides. Fact-checkers already use AI to discover disinformation and generative AIs may make that task more efficient. "Without AI, we cannot do content moderation at scale in a timely fashion," says Sarah Shirazyan, manager of content policy at Meta. "For example, AI can actively identify and detect harmful content, be it hate speech or mass production of fake accounts, and then take it down before thousands of users report it, or even see it."

But as previous research shows, content moderation won't be enough. "Fact-checking and debunking are not going to solve our problems," says Ceylan.

Effective interventions

One potentially more effective intervention is to borrow techniques from cryptography, says Paul Romer at Boston College, who shared the 2018 Nobel prize for economics. "What we need to do is to address this fundamental piece of infrastructure of digital authenticity: how do I know who's behind this? This is a solved problem in cryptography, there's a system called digital signatures, but we just haven't taken the trouble to implement it [on social media]."

In cryptography, digital signatures are used to verify the authenticity of the sender of a message or document, and the idea is that they could be adapted to verify that the producer of a social media post is human, says Romer. AI-generated content could also be forcibly digitally watermarked, making it easier for social media platforms to recognise and flag. According to Shirazyan, big companies including Meta, Google and OpenAI have agreed on voluntary commitments to do so.

There are other ways to mitigate information pollution. "A lot of people say the long-term solution is to have digital literacy courses in high schools to teach people to be more sophisticated technology users," says Howard. "But it's not always clear what a good digital literacy programme looks like. That will probably be one of the next things we work on at the IPIE."

We do at least have good models. According to Jussi Toivanen at Finland's National Cyber Security Centre, his country – which borders Russia and was recently the subject of a Kremlin-backed disinformation campaign alleging that Finnish social workers were taking Russian-born children into custody and selling them to gay couples in the US – has spiked the disinformation gun. "Media literacy has been part of our official school curriculum since the 1970s," he says. "It starts in kindergarten, it continues to basic education, it continues in adult education."

Finland is an exemplar, says van der Linden, who, for his part, has been experimenting with what he calls "inoculation". That is, exposing people to weakened doses of some of the standard psychological manipulation techniques – denial, deflection, conspiracy theories, trolling, gaslighting, fearmongering, inciting outrage and presenting false dilemmas such as "you're either with me or against me" – and then deconstructing them so people can build up cognitive resistance. A large body of evidence suggests that this inoculation approach works.

So the battle lines are drawn. On one side are the social media giants and the bad actors who flood their services with malign information, now armed with generative AI. On the other are the academics, legislators and the general public. How it plays out is hard to predict, but the outcome will affect us all, as nobody is immune to being played.

"The best-case scenario is that the research community can pull itself together in a coherent way to make reasonable demands about access to data," says Howard. "The worst outcome is that the technology platforms will simply refuse to comply and regulators won't have the political will to act." ▮

"YOU CAN GENERATE 10,000 LIES AND FIGURE OUT WHAT GOES VIRAL. WE'RE NOW PLAYING A VERY DIFFERENT GAME"



GRAEME SLOAN/BLOOMBERG VIA GETTY IMAGES

The attack on the US Capitol building on 6 January 2021 followed a conspiracy theory of electoral fraud during the 2020 election



Graham Lawton is a features writer at *New Scientist*



TONY BYNUM

Prairie power

Renewable energy development could help to restore North America's iconic prairies – if the opposition can be overcome, reports **James Dinneen**

A THIRD of North America was once an ocean of grass stretching from what is now central Canada to Mexico. Today, almost all of that original habitat, called prairie, is gone, ploughed for agriculture, paved over for cities and roads, or taken over by encroaching trees and shrubs. Most native prairie remnants are unmarked and hidden to the untrained eye – at least until the spring bloom reveals what grows there.

So, it was a surprise for Danish energy company Ørsted to learn that the field in which it planned to build a giant solar facility was among the largest areas of intact prairie left in Texas. It was also a "wake-up call" for conservationists, says Kirsti Harms at the Native Prairies Association of Texas. "Suddenly there are thousands of acres going into these solar projects." Unlikely as it seems, this could be good for both clean energy and biodiversity.

Rapid development of renewable energy facilities, such as solar farms and wind turbines, is necessary to cut greenhouse gas emissions and fight climate change. But the industry's demand for rural land – what Tracy Stone-Manning, director of the US Bureau of Land Management, calls "the greatest land-use transformation in modern history" – has generated intense opposition among local communities across the US. Amid this, researchers and some developers, including Ørsted, are looking for ways to make facilities that

Listen to Danny Kennedy, host of the *Climate of Change* podcast with Cate Blanchett, discuss solar power's potential
newscientist.com/nslmag

bring benefits not only to rural populations but landscapes too.

The one that has perhaps gained most traction is the idea that solar development can restore lost habitat if native flora is planted beneath panels, supporting birds and insects and improving the soil on potentially millions of hectares. This, the argument goes, could finally herald the return of the iconic prairie.

Benefits for all

The ongoing energy transition in the US requires vast amounts of land. A recent report from The Nature Conservancy found that the current trajectory of energy development would need more than 650,000 square kilometres, about 7 per cent of the continental US or an area more than twice that of the UK.

This transformative enterprise has gained momentum as a result of huge investments from state governments and the private sector as well as the falling costs of renewable energy. It has also provoked increasing opposition. "We're seeing growing resistance in local communities to the deployment of these clean energy projects," says Grace Wu at the University of California, Santa Barbara, and an author of the report. "We need to do what we can to make sure this is generating benefits for everybody."

One approach would be to reduce the overall amount of land needed. Wu and her colleagues found that this could feasibly be almost halved through strategic choices about where and what to build. Carefully siting these remaining developments could avoid most impacts to valuable habitat and prime agricultural land, while increasing the cost of the transition by only about 6 per cent. For example, putting projects nearer cities would reduce land needed for transmissions lines. Wind and solar could be built together on the same land. More solar panels could also be put on rooftops and over car parks. However, this wouldn't avoid the need for lots of ground-level solar panels, says Wu. "We need all of it."

Another approach is to design renewable energy projects so the land they occupy can still be used for other things. Growing crops or grazing livestock underneath solar panels – known respectively as agrivoltaics and rangevoltaics – is proving promising. The added shade can help some plants deal with drought and be more productive. Sheep also appear to benefit from grazing under solar panels, thanks to the shade they provide and the more nutritious grass that can thrive there. This is a growing field of research and there are signs of support for agrivoltaics across the political divide. However, such projects can be expensive and are likely to happen on only a few hundred square kilometres of land.

"The industry's demand for land has generated intense opposition"

Another dual-use approach that could have much wider potential application is to use energy development to restore habitat. For instance, wind turbines off the north-east coast of the US, which have been falsely linked to the deaths of whales, could actually provide anchor points for marine habitats. If carefully constructed, solar facilities in deserts of the south-west US could shade and protect wild tortoises and plants rather than endanger them. And solar facilities atop lost prairies could help bring them back. "We can use infrastructure in a way that provides ecosystem services," says Wu. However, many questions remain about how to make this work, she adds.

Some researchers and energy companies are already addressing them. At Ørsted's Texas development, for example, the company plans to collect seeds from the site's intact prairie and plant them across the rest of the facility. Developers have also planted prairie habitat in Minnesota, which, in 2016, became the first state to adopt a "pollinator friendly" certification programme to rate the quality of the environment at solar facilities. It scores them based on a range of factors such as the diversity of native flowering plants and the area they cover. New York, Maryland, Vermont and Illinois have since begun similar efforts.

Meanwhile, Matthew O'Neal at Iowa State University and his colleagues are beginning to test ways to integrate pollinator habitat and beekeeping with solar facilities. Hopes are high after his group found that strips of prairie planted between rows of crops had positive effects on honeybee health. "I have some confidence we can do this under solar panels," he says. And in California's agriculture-rich Central valley – much of which was once prairie – Rebecca Hernandez at the University of California, Davis, is running a test project on a small solar facility built on the site of a decommissioned nuclear power plant. Results there will determine the best mix of plants for restoring California prairie habitat and supporting animals that live there, such as the threatened California tiger salamander (*Ambystoma californiense*).

Restoring habitat under solar panels is far from the norm. The usual procedure is to level the ground, cover it with gravel and fence it off. Even in states with "pollinator friendly" programmes, restoring prairie habitat is voluntary, says Leroy Walston at Argonne

JAMES DINNEEN



A planned solar facility on prairie land in Daphne, Texas, is being opposed by environmentalists





Growing native plants under solar panels may benefit prairie land and boost honeybee health

L: ARGONNE NATIONAL LABORATORY R: DANITA DELIMONT CREATIVE/ALAMY

National Laboratory in Illinois. But, he says, developers usually make some effort or else risk being blacklisted by environmental groups. "It's almost a requirement now," he says. In Minnesota, for instance, more than 12 square kilometres of solar facilities are rated as pollinator-friendly, roughly half of the area covered by solar in the state.

However, even where planting happens, efforts vary. What gets planted largely depends on how much a developer is willing to spend. Access to native seeds can be an issue, and even when they are available, they cost more than basic clover or turfgrass. Ecological surveys cost money. What can grow also depends on how high the panels are raised and how much shading of the panels from tall plants operators are willing to tolerate. Walston says raising panels by just 25 centimetres extra can enable a greater diversity of plants – although this requires additional steel, and extra cost.

Prescribed burning

Then there are decisions about the maintenance needed to ensure seeds grow and outcompete invasive plants. Mowing is better than herbicides for pollinators. Some sites use goats or sheep to control vegetation through grazing. Prescribed burning would be ideal, says Walston: native prairie plants have deep roots adapted to withstand fire. Indeed, fire suppression by European settlers is a major reason for the loss of prairie to encroaching woody plants. However, burning hasn't yet been tried at a solar facility to his knowledge. Beneath solar panels or not, "prairie restoration is not going to be easy", says Harms.

Restoring habitat isn't all expense, though. Once established, a solar prairie might actually require less maintenance than close-cut turfgrass and it may be less prone to erosion than gravel, says Walston. Prairie locks up carbon in the soil, so restoration projects could be marketed as carbon credits. Research has also found that having vegetation beneath panels improves their efficiency on hot days by cooling them. The scale of these benefits is potentially vast. In California alone, Hernandez envisions solar developments that incorporate prairie restoration happening on the hundreds of thousands of hectares of farmland set to be taken out of production to prevent overuse of groundwater.

Nevertheless, there is no guarantee that any of this will stem opposition to new developments. "We don't have a grand model for a way to build out solar that will make everyone happy," says Hernandez.

In Texas, where solar energy projects are being developed faster than anywhere else in the US, some people feel rural land is being sacrificed for energy hungry cities and cite concerns about the impacts on soil and vegetation, as well as the changing character of rural places – and prairie in particular. "Unless we have guarantees that the land is protected, we don't want anything to happen," says B. F. Hicks, an attorney and conservationist based in Mount Vernon. Other fears range from concerns about fires from battery storage facilities to the fact that the developments are largely being created by foreign companies.

There is some legal opposition too. It is likely to become more challenging for solar and wind projects to be built in Texas at all due to new anti-renewable legislation adopted by the state government, some of which is in response to environmental concerns. Though the new rules aren't as restrictive as clean energy advocates had feared, the fact this is happening at all in famously unregulated Texas highlights the central role state and local planning will play in clean energy development across the US. "The community licence part of deploying all of this clean energy is going to be increasingly important," says Wu. Developers and governments could avoid a lot of opposition, she adds, by engaging with local communities early on about what to build and how they might benefit.

More prairie habitat is one possible upside. But it is early days. O'Neal points out that even the most sophisticated restoration projects are still in an experimental phase and it remains to be seen what the quality of habitat that gets planted is and how well it is maintained. "We need a lot more science to be able to deploy large-scale restorative energy projects," says Wu. However, she is optimistic. As is Hernandez. "We have to build out renewable energy infrastructure, but we don't have to sacrifice our ecosystem services to do that," she says. It depends on the developer whether a site ends up a "barren wasteland" or something more, she says. "People want to see beautiful things in their communities." ■



James Dinneen is an environment reporter for *New Scientist*, based in New York

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
How do dogs recognise that other dogs are dogs? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Dead ringers, head games and trivial superpowers p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Stargazing at home

Swanning along

This is a great time to spot the constellation Cygnus and its lovely stars – including stunning double star Albireo, says **Abigail Beall**



Abigail Beall is a features editor at *New Scientist* and author of *The Art of Urban Astronomy*. Follow her @abbybeall

What you need

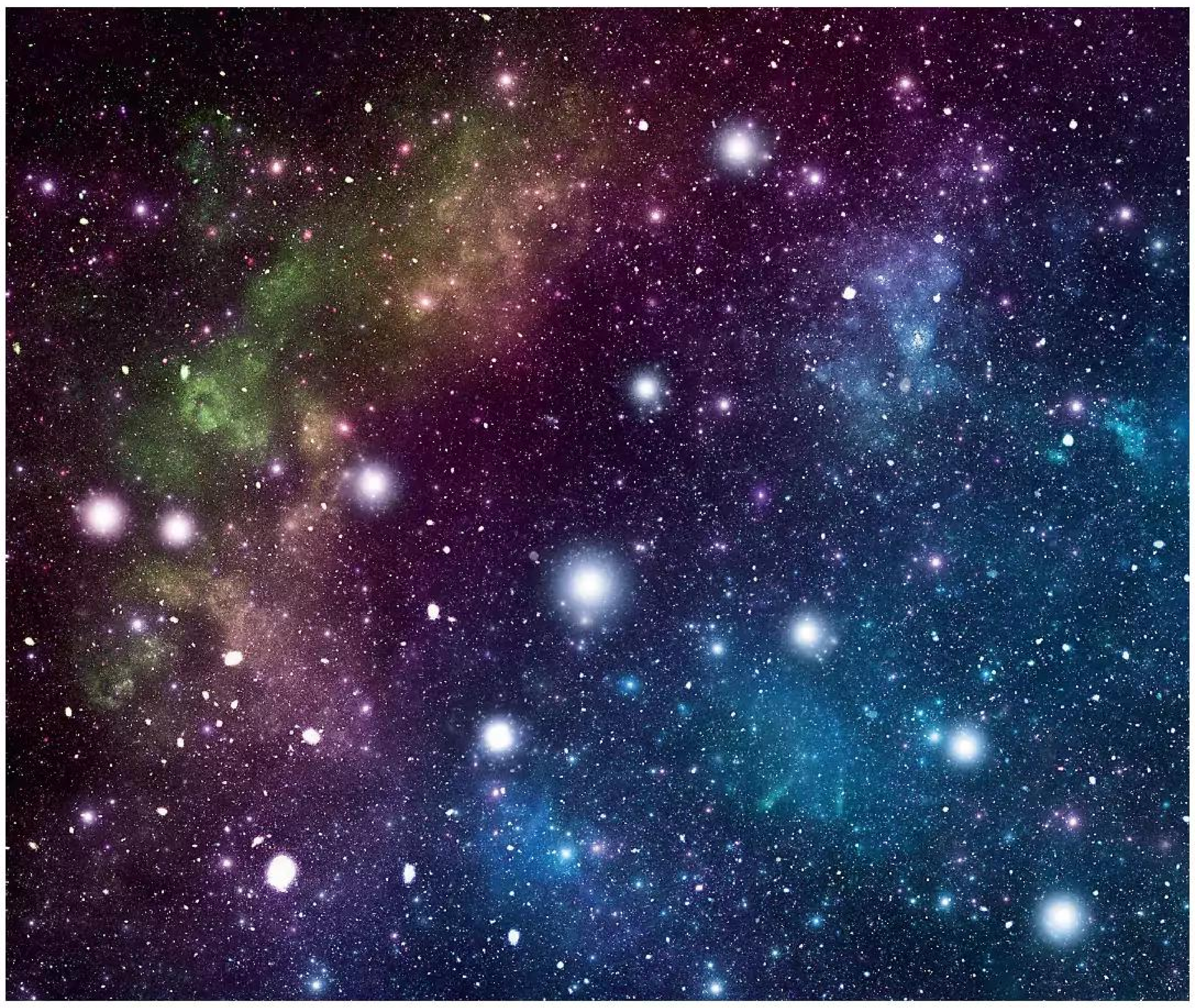
Binoculars or a small telescope

CYGNUS the swan is a beautiful constellation filled with plenty of interesting stars and deep-sky objects. It is visible this time of year almost anywhere in the world: in the northern hemisphere it sits high overhead throughout the night, while in the southern hemisphere it appears lower in the sky, towards the north, as soon as it gets dark, and sets a few hours later.

To find Cygnus, you can use a pattern of stars, or asterism, called the summer triangle, so named because it is directly overhead in the northern hemisphere during summer. In the northern hemisphere, look east when it is dark to see the three brightest stars making up a large triangle. Vega will shine highest in the sky, with Deneb, which is in Cygnus, to its left and Altair below. In the southern hemisphere, Altair will be highest, with Vega and Deneb closest to the horizon.

To find the rest of Cygnus, look between Deneb and the other stars of the summer triangle. Within them you will see four more bright stars making up a cross shape, sometimes called the northern cross. Deneb – which forms the tail of the swan – is at one end, while directly opposite, and in line with Vega and Altair, is a star called Albireo – the head of the swan. The rest of the cross, and the wings of the swan, stretches out in a line perpendicular to an imaginary line drawn between Deneb and Albireo.

Albireo is a double star, meaning it is made up of two stars.



SERGII TSOLOLO/ALAMY

This makes it one of the loveliest stars to look at through a small telescope because you can easily see both stars: one larger and yellowy orange in colour and the other smaller with a blue-green hue. Technically, the brightest star is called Albireo and the other, which is about 390 light years away, is Beta Cygni B.

Cygnus is also a great constellation to look at through binoculars because its position along the Milky Way means there is plenty to spot. The stars 30 and 31 Cygni make up a double star that can be seen with binoculars, while there are a few visible open clusters of stars, including Messier 29, close to the centre of the swan.

There are historically important stars in Cygnus, too. In the 19th century, the star 61 Cygni was the first to have its distance from Earth measured by German astronomer Friedrich Wilhelm Bessel. He did this by measuring how the position of the star in the sky appeared at different points in Earth's orbit around the sun. This was the first example of measuring interstellar distances using a technique called parallax, which is still important today.

It works on smaller scales, too. With one eye closed, extend your arm in front of you and make a thumbs up. Then, open your closed eye and shut the other: your thumb appears to move. This is because you are viewing it from your other eye.

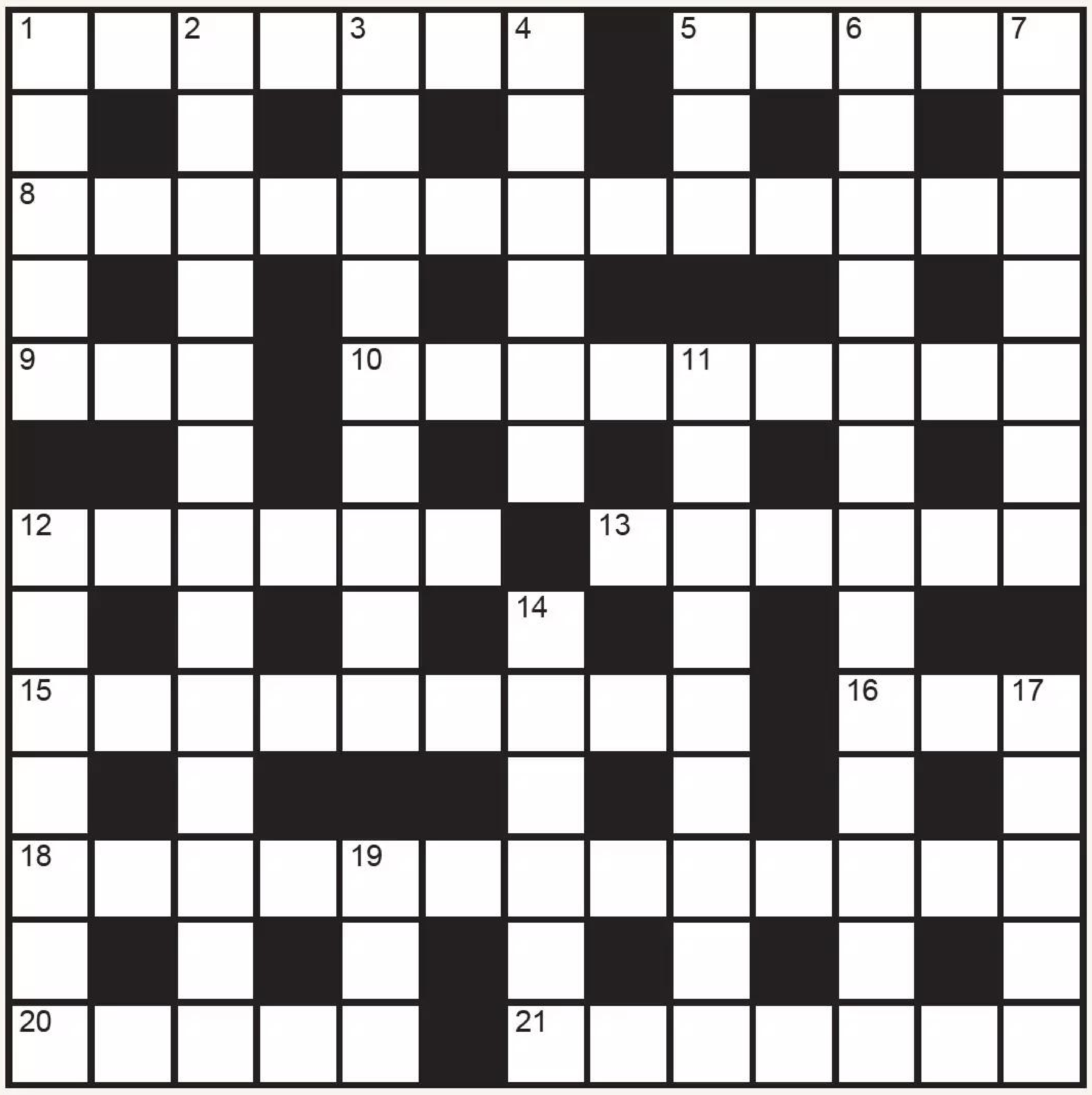
Stargazing at home appears every four weeks. Share your stargazing successes with us on Twitter and Instagram @newscientist, using the hashtag #NewScientistStargazing

Next week

Mathematics of life

These articles are posted each week at newscientist.com/maker

Cryptic crossword #118 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Ring to cancel superpower (7)
5 Becquerel birthplace, where one's after what one should go round in (5)
8 Appliance for space buffs? (6,7)
9 Shelter rebel general (3)
10 Norman and Don confused – this is no accident! (3-6)
12 Reconstruct in rope, getting chilblains (6)
13 Cramps before texting centre for treatments (6)
15 Monumental main course left unfinished in the middle of the crisis (9)
16 Soldier, perhaps, using magneto regularly (3)
18 Came across aluminium, etc., mixed up with rot and eroded walls, using this? (5,8)
20 Memory of online ball (5)
21 Mass centre's zero (type of unit, in division) (7)

DOWN

1 Something to get hammered on? Might be Smith's (5)
2 Muddled, with little change, over the weeks following fall – this might be the end (7,6)
3 Woman inhaling last of prescribed nitric oxide, making a din (4,5)
4 Ordinal found in corner (6)
5 Graph is almost entirely black and white (3)
6 He thought, so was seen, caught and arrested, disgracefully (4,9)
7 Saves money, after trading hundred for Henry's seaweeds? (7)
11 Astatine's here now! (2,7)
12 Empire going wild with ecstasy, for she's arrived ahead of schedule (7)
14 Master corrupted? Watch online! (6)
17 Doughnut for roustabout (5)
19 Scientific Pole is inclement (3)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #219
set by Bethan Ackerley

1 What is the SI unit of inductance?

2 Vertebrates with two lungs that flex their bodies sideways during locomotion find it difficult to breath and move at the same time. What is this observation known as?

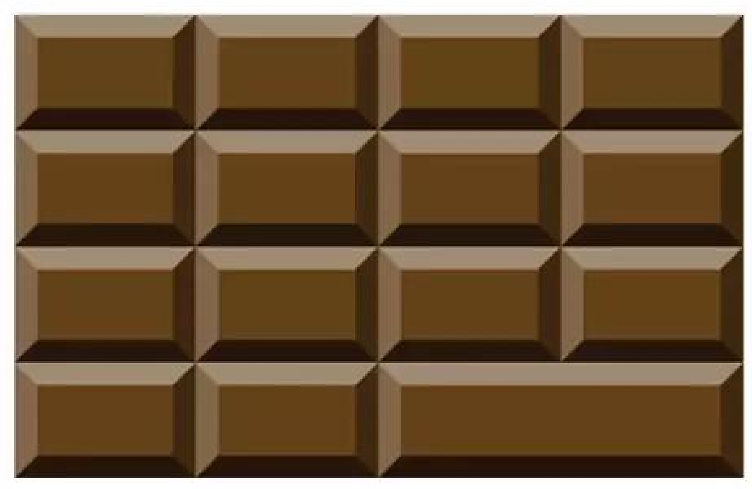
3 In the human body, which has more bones, the appendicular skeleton or the axial skeleton?

4 In mathematics, what does the letter e represent?

5 When was superconductivity discovered?

Answers on page 47

Headscratcher
set by Brian Hobbs
#239 Snap judgement



The current Guinness World Record for the largest chocolate bar by weight belongs to confectionery firm Thorntons for the 5792.5 kilogram bar it created in Derbyshire, UK, in 2011. The illustration above shows how the bar was arranged: in 15 segments, with one larger than the rest.

Separating the bar into its individual segments would be no small feat. In order to break the bar up, you would need to snap it multiple times along an entire line, either horizontally or vertically.

What would be the minimum number of snaps required to separate all 15 segments from each other? (By the way, no stacking of pieces before you snap them!)

Solution next week

Two of a kind

How do dogs recognise that another animal is also a dog when there is such a vast array of canine shapes and sizes?

Garry Trethewey
Arkaroola Wilderness Sanctuary, South Australia

The obvious answer might be "by smell, not by sight". But it isn't that simple.

Epistemology is a branch of philosophy that asks: "'What is knowledge?" So what does "recognise" mean?

Dogs respond to other dogs, as well as people and sometimes goats, sheep and geese, based on a range of stimuli. Sometimes, it is familiarity; sometimes, it is smell.

They might approach other dogs and humans in amorous or aggressive ways.

It can be said they "recognise" the object of their attention, in the sense that they would respond to a block of wood differently. But we have no way of knowing how or if a dog "recognises" another dog as being different from its owner or any other familiar creature.

"We have no way of knowing how or if a dog 'recognises' another dog as being different from its owner"

Robert Stuart
San Francisco, California, US

Do dogs know that other dogs are dogs just by looking at them? That is the question researchers in France wanted to answer in 2013.

They conducted a study with nine companion dogs who were trained and had experience with both dogs and people. The researchers wanted to see if they could recognise other dogs based solely on appearance, without relying on their sense of smell.

All the dogs in the study knew their way around both dogs and humans. And let me tell you, they didn't all look the same – there were two pure-bred dogs and the rest were mutts.

So, here's how it went down: in each trial, the dogs looked at two screens, one on the right and one on the left, with a divider in between. The screens showed two images at the same time. If the dogs approached the screen with the "right" image, they got a click and a treat.

To see if dogs could identify other dogs just by their looks, the researchers needed to establish some common ground with their furry subjects. They did this by having three training sessions where the dogs only got a treat when they approached the screen with a dog's face.

It was important that they used the same picture of a dog throughout the training sessions. The other screen either showed all black, all blue or a picture of a cow's face – approaching those wouldn't get the dogs any treats. The researchers wanted to make it clear they would only get rewarded for approaching the "dog" image, nothing else.

The dogs had to choose the dog image correctly at least 10 out of 12 times in two consecutive sessions. And guess what? All nine dogs nailed it! They seemed to understand the common language that the researchers had set up.

I have done a number of similar experiments myself over the years. Dogs are amazingly perceptive creatures and I have been fascinated with them my whole life.

Peter Scott
Radlett, Hertfordshire, UK

I am pretty sure that dogs recognise other dogs in much the same way as we do: years of visual pattern recognition.

What I really don't understand is how my dog Daisy knows that a fox isn't a dog. For Daisy, a fox is worthy of hysterical barking and lunging, a behaviour she doesn't exhibit with *Canis familiaris*.

She does this even when upwind of the fox at 30 metres or more.



MARSHAL HEDIN (CC BY-SA 2.0)

What is the smallest that an adult arthropod can be, if there is indeed a limit?

This week's new questions

On the small side **Is there a limit to how small an adult arthropod can be? If so, what is the reason for the limit?**
Elaine Lovitt, *Gladwin, Michigan, US*

Spinning out **What makes galaxies spin in a certain direction? And do they all spin in the same direction?**
John Cleveland, *Bloomington, Indiana, US*

Cold spray

Why is it that, when spraying an aerosol can of deodorant, it suddenly becomes very cold when it runs out?

David Jackson
Gosport, Hampshire, UK

Many aerosols use a mixture of the hydrocarbon gases propane and butane as their propellant – the material that drives the contents out. This is because these gases are liquids at a couple of atmospheres of pressure, which is easily contained in a metal can.

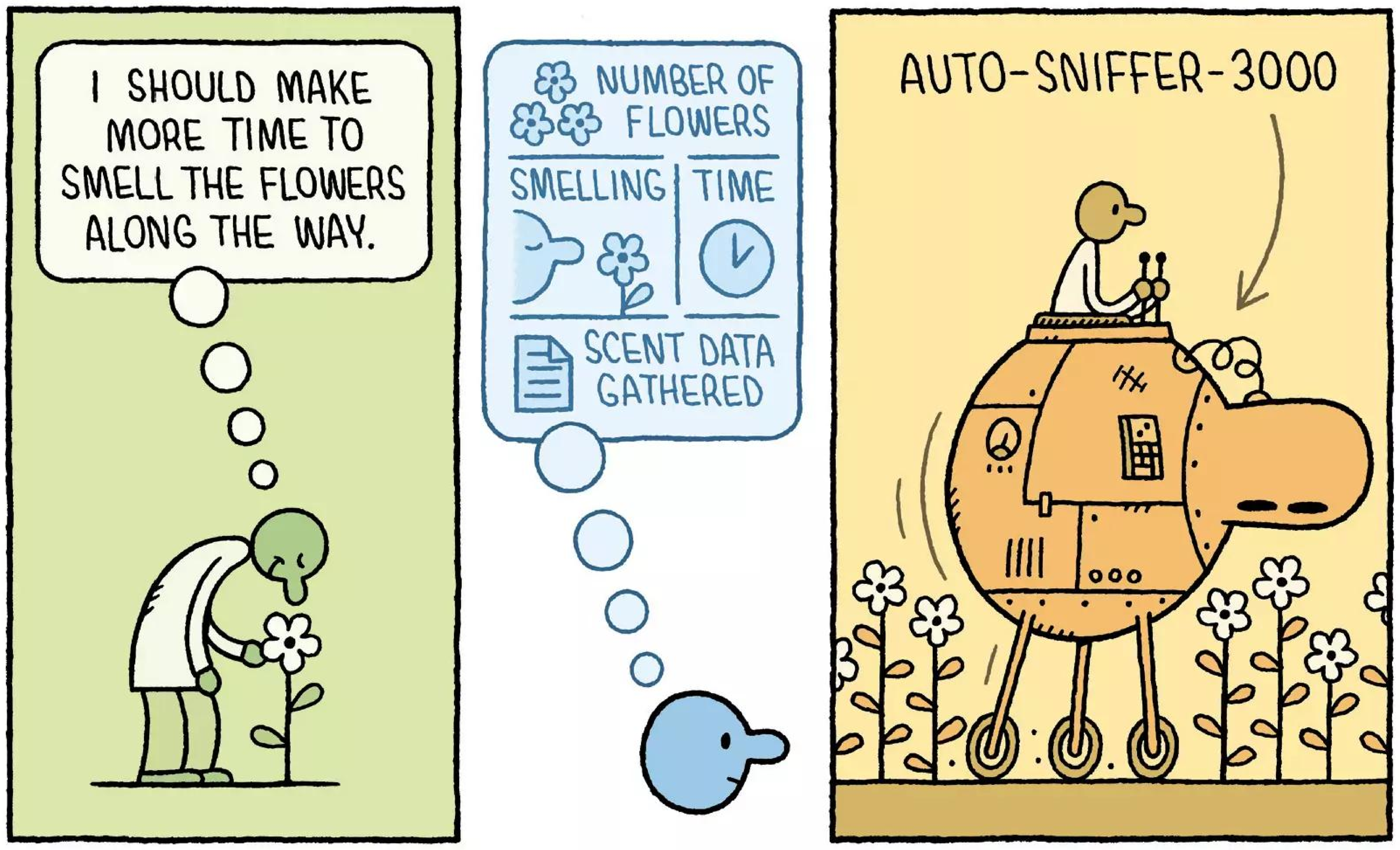
Anyone who has handled a transparent gas lighter will have seen this, where the butane fuel is visible as a liquid with gas above it. The same is true in the aerosol can, with the product mixed in with the liquefied gas.

When the can button is pressed, the pressure is released and the gas and product spray out. Meanwhile, some of the liquid propellant turns to gas to maintain the pressure, so the can always seems to have the same spraying ability. This causes a slight, but much less noticeable, temperature drop unless the can is used for a long time.

When the liquid product has all gone, the propellant can come out

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Tom Gauld
for New Scientist



much faster, as the gas doesn't have the product "in the way". The remaining liquid propellant therefore evaporates faster and cools more noticeably.

As an aside, propane and butane aren't directly greenhouse gases, though once in the atmosphere they oxidise to water and carbon dioxide, and the latter is, of course, a greenhouse gas.

David Muir
Edinburgh, UK
When you sweat, the sweat evaporates. The phase change from liquid to gas requires heat to break the intermolecular bonds between the molecules of liquid. This heat is supplied by your body, which is why sweating cools you down.

Aerosol propellants readily boil at room temperature and are only liquid inside the can due to pressure. When the nozzle is pressed, the pressure is released and the propellant boils, taking heat from its surroundings, mainly the liquid in the can. This then cools the can slightly – not easy to notice with a short spray.

> **"With continual spraying of an aerosal can, condensation may form on the outside of the can and might even freeze"**

With continual spraying, condensation may form on the outside of the can and might even freeze. This shouldn't be tried indoors, as some propellants are highly flammable.

When the can is almost empty, the last "scoosh" requires as much heat as the first, and all that is left to heat the propellant is the can. The resultant temperature drop feels cold to your sensitive fingers.

Guy Cox
Sydney, Australia
Your aerosol consists of a liquid – the deodorant – and the propellant, a compressed gas.

When a gas expands, in the absence of external heat, it cools. That is because work is done moving the molecules further apart, and the energy for that has to come from the temperature of the gas. Hence air is thinner, and cooler, in the mountains.

So every time you use your spray, it will actually be cooled, but the amount of gas stays the same and the amount of liquid decreases, so initially the effect won't be noticeable.

Of course, after use, everything comes back to room temperature. But once there is only a little liquid left, the cooling effect makes itself felt.

Good boy

Why do humans pat animals on the head? I know we do it with cats and dogs, but I recently saw footage of a diver trying to pat an octopus. (continued)

Felix Ansell
Haworth, West Yorkshire, UK
Because it is either much safer than patting anywhere within easy reach of teeth or claws, or, in the case of an octopus, 87.5 per cent easier than shaking limbs.

Answers

Quick quiz #219
Answers

1 The henry
2 Carrier's constraint
3 The appendicular skeleton, which has 126 bones to the axial skeleton's 80
4 Euler's number
5 1911

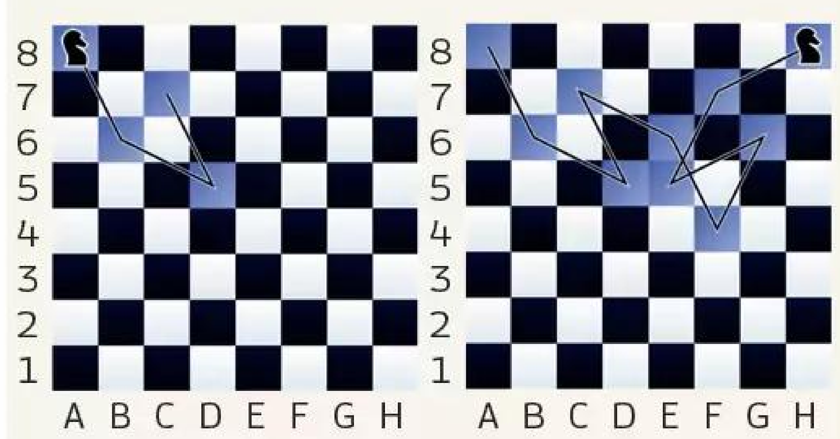
Quick crossword #141 *Answers*

ACROSS 1 Hyper, **4** Jonas Salk, **9** Dark web, **10** The clap, **11** Osmic, **13** Alert, **15** Sea, **16** Odd, **17** Bragg, **19** Guano, **21** Litre, **23** Butyl, **24** Doc, **25** CPU, **26** CD-ROM, **28** Hazel, **29** Added up, **31** Rubella, **33** Greenwich, **34** Wedge

DOWN 1 Hydrofoil, **2** Pyramid, **3** Row, **4** Jabba, **5** Nit, **6** Sweat, **7** Aplasia, **8** Kappa, **12** Cable, **14** Eight, **18** Amber, **19** Galah, **20** Oscillate, **22** Trundle, **24** Dazzled, **25** Clang, **26** Codon, **27** Morph, **30** Phi, **32** Bow

#238 Knight shift
Solution

The knight starts on a black square somewhere in the board's top left quarter. The only square where she can be trapped after three moves is the corner one, A8, starting on B6 or C7 (shown bottom left). If the knight is to land at least once in each column and be trapped a second time, the initial square must have been C7 and she must end on H8. The only nine-hop path in which she visits the bottom half of the board just once is shown below right.



When conversation dies

"Can the dead communicate with cell phones?" asks the headline of a press release from King's University College, Canada.

This has nothing to do with a question commonly asked by ill-informed people: "If a cell phone is dead, will it ring or go straight to voicemail?" Answers to that query are available to anyone who does an internet search.

The press release explains: "Dr. Imants Barušs, Professor of Psychology, has been awarded a $44,500 BIAL Foundation Grant for Scientific Research for his study After-Death Communication with Cell Phones."

The BIAL Foundation, says its website, "was created in 1994 by the BIAL pharmaceutical company and the Council of Rectors of Portuguese Universities". The foundation's stated aim is to stimulate new research that "attains new knowledge".

In the press release, some outstanding questions – questions for the telecommunications industry – go unmentioned. How, when and where do the dead obtain cell phones? From which carriers (T-Mobile? Vodafone? Virgin Mobile?) do the dead obtain dependable phone service? Is that service available only to people who died after mobile phones were invented? It is hard to find authoritative answers to these queries. Feedback's initial attempts have produced predictably dead ends.

Twisteddoodles *for New Scientist*



Got a story for Feedback?
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or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Gaming with Freud

Freudian psychotherapy, sometimes mocked as an entertaining but phantasmagorical relic from the old days, is alive and treating the unwell in the community of internet gamers.

Georgios Floros and Ioanna Mylona in Greece gave a dose of Sigmund Freud to a gamer they call "George". In a report titled "A psychoanalytic approach to internet gaming disorder", they use Freudian language to analyse him: "George needed to prove himself in the eyes of his mother in order to receive affection, yet her gaze was not following him during his early childhood but her own ersatz selfobject."

The pair also analyse their analysis: "Despite his treatment, George found himself unable to progress, having half-dropped out of his engineering studies, limiting himself to bouts of gaming, online scuffles on politics with strangers, binge-eating and smoking marijuana."

Floros and Mylona also treated a gamer they call "Paul". They reveal that: "In an open-ended scenario Paul found himself being chased by an aggressive gorilla away from a Mayan temple, depicting his aggressive tendencies that plagued his emotional relationship, although he managed to outrun it."

Back in 2019, Michel Nogara and Alfredo Naffah Neto at the Pontifical Catholic University of São Paulo, Brazil, told an audience at the 16th European Congress of Psychology in Moscow about "Psychoanalytic findings of the internet gaming disorder".

The researchers used a technique they call "Netnography" to psychoanalytically study Brazilian compulsive gamers. What they discovered has the potential to inspire, enrage, cure, confuse or in no way affect any or all compulsive gamers, be those gamers in Brazil or elsewhere.

Nogara and Neto said: "Our findings point to the role of the ideal ego in gaming, where the subject tries to reach the narcissistic ideal self again, as once supposed by its parents, in single or multiplayer games."

Gamers in distress, be aware that this kind of help is available to all of you.

Unseen borders

The borders between trivial superpowers, trivial non-superpowers, non-trivial superpowers and non-trivial non-superpowers can be hard to discern.

Trevor Howland gives an example for students to stop and savour as they stroll through Feedback's growing catalogue of trivial superpowers: "My trivial superpower is to be able to walk in a straight line with my eyes closed. I can also look at a room, and close my eyes (or turn off the light), and be able to avoid all obstacles to get out of the room."

Robert Senior, too, expresses uncertainty about the borders: "When I was a teenager in Glasgow, I was found to have flat feet and knock knees. I was sent to a clinic where I was given exercises to correct this. One exercise was picking up marbles with my toes. I still have flat feet and knock knees but also a remarkably useful ability to pick up things with my toes. Does this count as a superpower?"

Robert's case is of special interest to people who worry about losing their marbles. Feedback has submitted both Trevor's and Robert's inquiries for disposal by the Trivial Superpowers Assessment Board, which doesn't yet exist.

Double-hander

Rosemary Firman, meanwhile, highlights a maybe not-so-trivial trivial superpower: "My husband Roger, who has been blind from birth, has the ability to read both sides of a page (written in Braille) at the same time, one with each hand. He can also read two parts of the same page or two pages in the same book (or even two different books) at once and often does so in order to locate a particular passage quickly. How his brain manages this I cannot comprehend." ▮

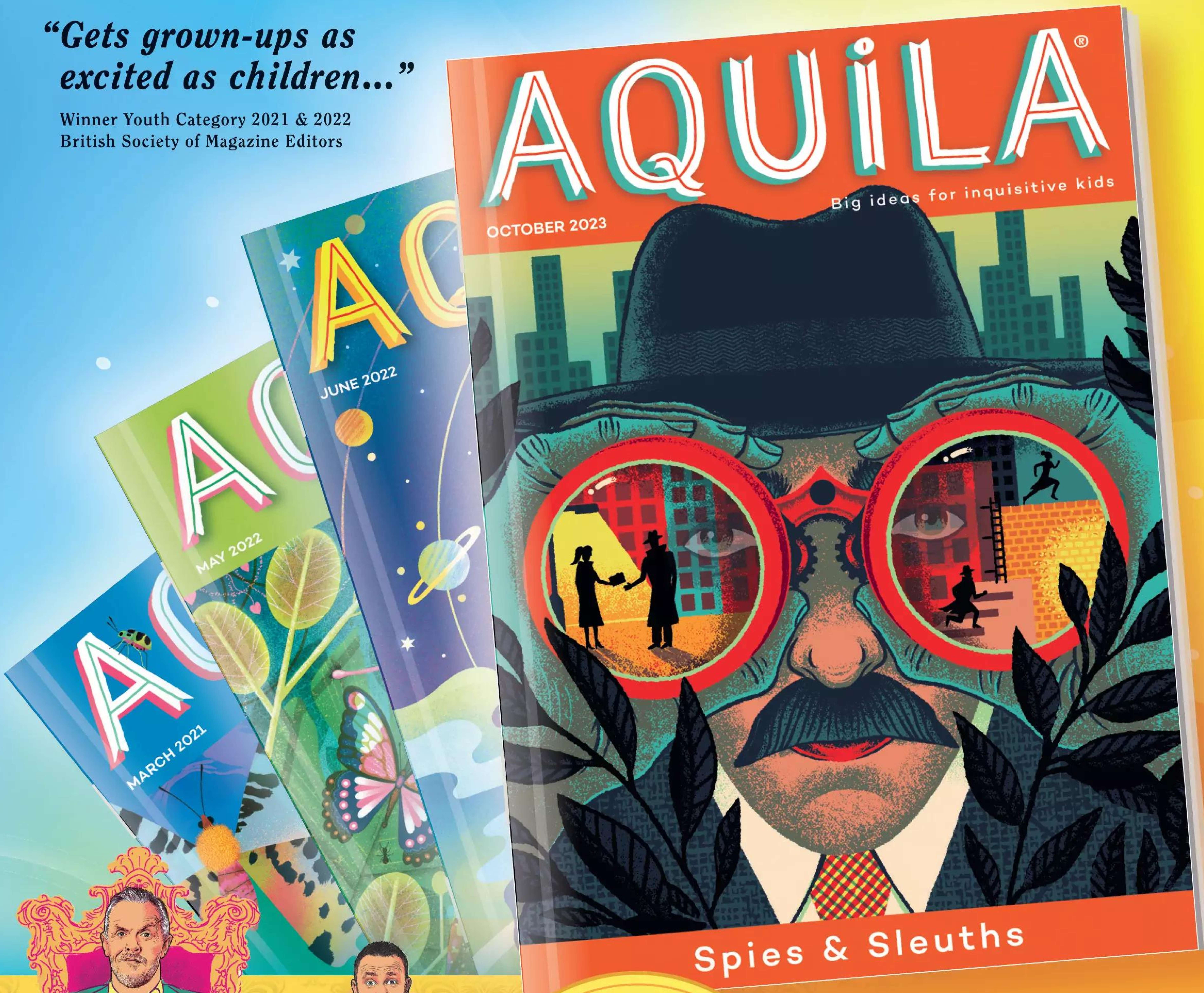
Marc Abrahams

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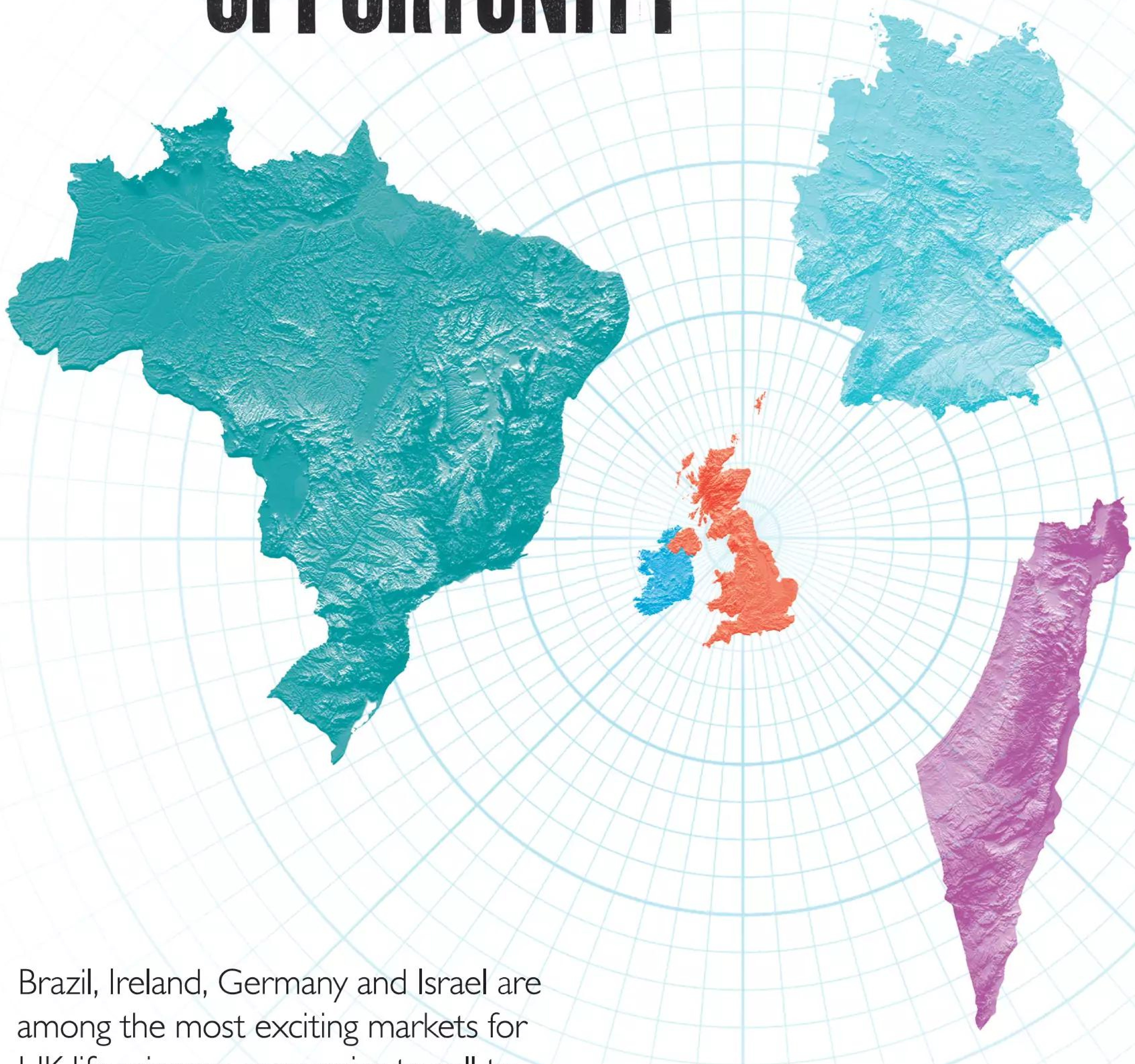
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